# ORDNANCE

## LAND • SEA • AIR ARMAMENT

Talos in Action

MARCH-APRIL 1958

SPECIAL PICTORIAL REPORT ON COMBAT AIRCRAFT....PAGE 816A

# Name your bearing needs...we'll meet 'em pronto from 30 types, 10,247 sizes

TIME and time again, machinery makers come to the Timken Company for help with some special bearing application problem. One they think hasn't been solved before. And time after time, from our 30 types and 10,247 sizes of Timken® tapered roller bearings, we've come up with the bearing design to do the job and at minimum cost.

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# ORDNANCE

*The Magazine of Scientific and Industrial Preparedness Now in Its 38th Year*

## LAND · SEA · AIR ARMAMENT

VOL. XLII MARCH-APRIL 1958 NO. 227


**The Cover.**—*The Talos surface-to-air missile is a beam rider with special steering system and a proximity fuze. It is ramjet-powered to Mach 3.5 and has a range of about 75,000 feet.*


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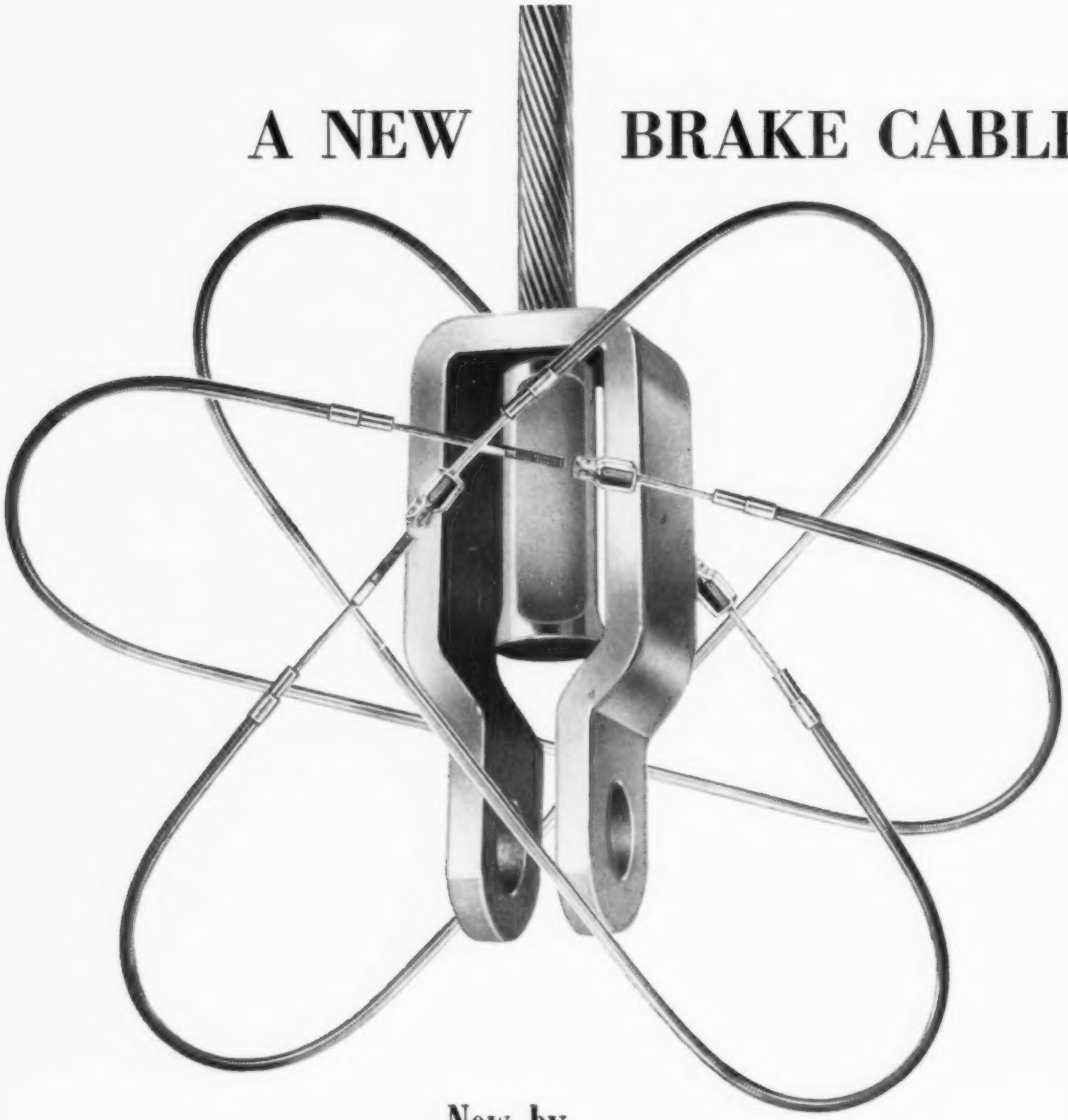
# A NEW BRAKE CABLE



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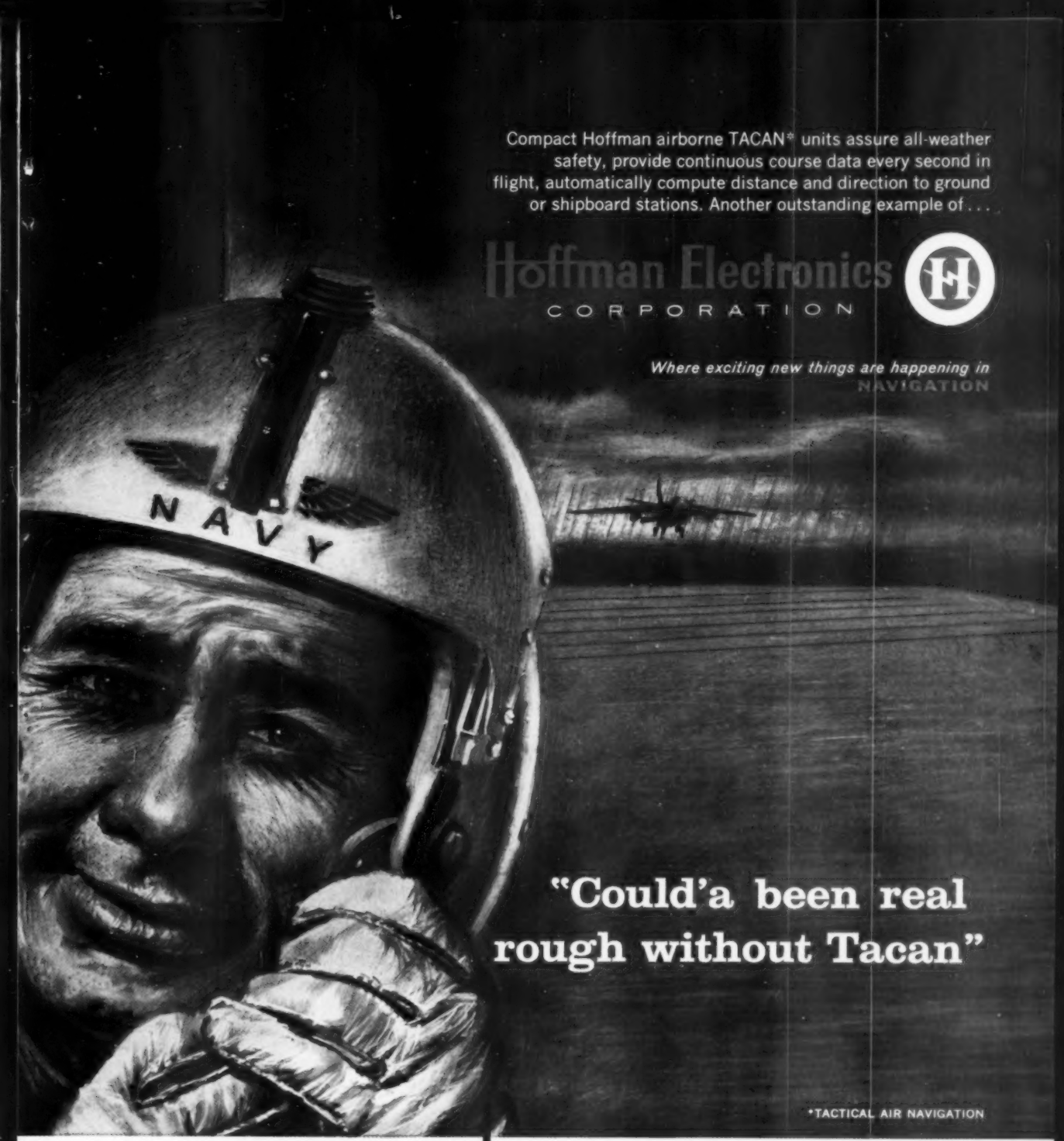


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*TACTICAL AIR NAVIGATION

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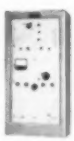

TACAN-VORTAC Beacon Simulator

TACAN-VORTAC Cockpit control panel

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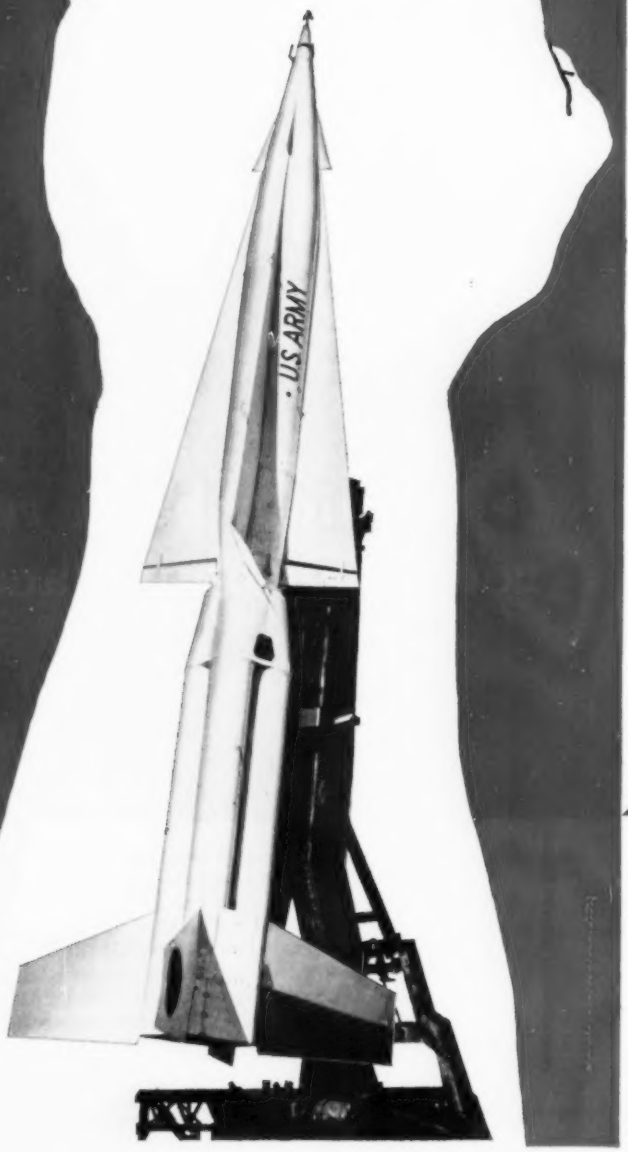
## A SUNDAY PUNCH FOR DAILY USE!

### Army's Nike-Hercules



An Army missile with a lethal wallop, the Nike-Hercules will deliver a knock-out blow to enemy air aggression—Sunday and every day, around the clock. Nike's knuckle-duster is its warhead—loaded and tested, developed and delivered by Aerojet-General's Explosive Ordnance Division.

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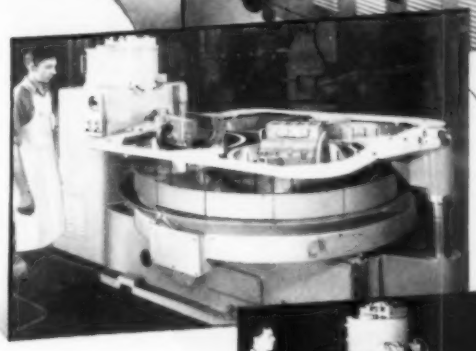
¼-in. dia. parts per load.

Model 24 handles 3
9½-in. dia. parts up to 3900
¼-in. dia. parts per load.

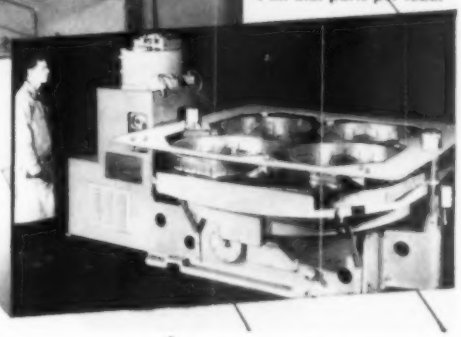
Model 36 handles 4
13¾-in. dia. parts up to 4000
⅜-in. dia. parts per load.



Model 48 handles 4
17-in. dia. parts up to 940
1-in. dia. parts per load.

Model 72 handles 4
27-in. dia. parts up to 2480
1-in. dia. parts per load.

Model 84 handles 4
32-in. dia. parts up to 3500
1-in. dia. parts per load.



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Crane Packing Company, 6480 Oakton St., Morton Grove, Ill. (Chicago Suburb).
*In Canada: Crane Packing Co., Ltd. 617 Parkdale Avenue, Hamilton, Ontario.*

## Free data

*These 3 booklets on Production Lapping and Light Band Reading are yours for the asking. Write today.*

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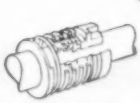

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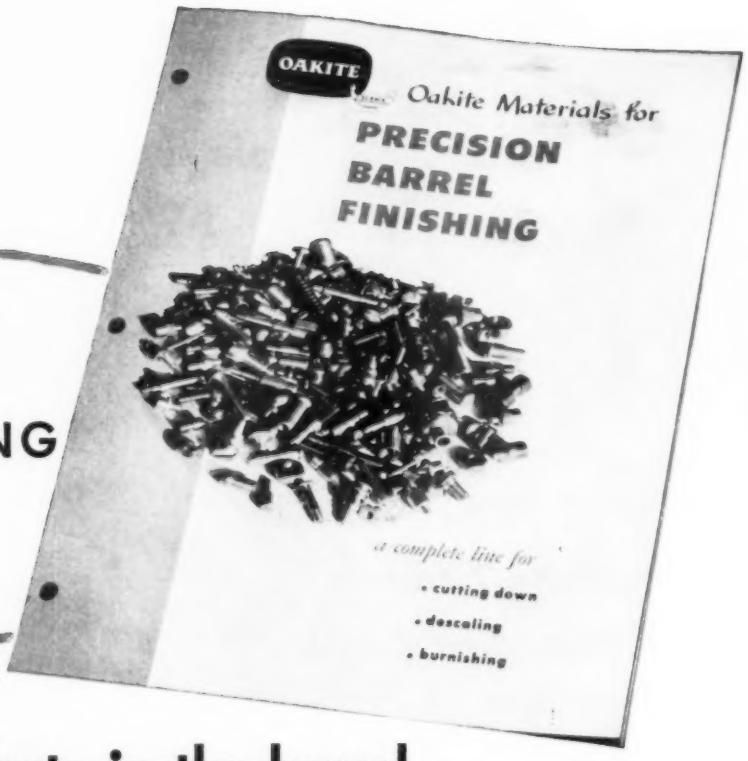
**CRANE PACKING COMPANY**

HERE'S AN EXCITING GAME




# PUT your products in the barrel TAKE your profits out

A great way to save money is to barrel finish metal parts by the hundred instead of manually finishing one part at a time.

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*tests America's*

# 'SUNDAY PUNCH!'

**UNDER THE BLINDING GLARE OF LIGHTS**
**EXPERT TECHNICIANS AND SCIENTISTS TOGETHER**
**READY ANOTHER GIANT MISSILE FOR FLIGHT**

*where*

AC

*fits in this picture*

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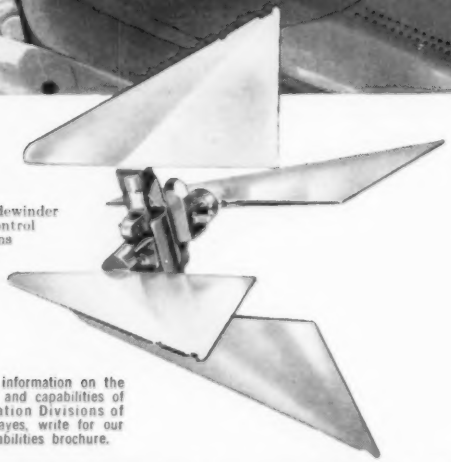

Sidewinder Control Fins

For full information on the products and capabilities of the Aviation Divisions of Kelsey-Hayes, write for our new capabilities brochure.

## target... enemy tail pipes!

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**DRIVER'S SEAT** and controls are located in the front, engine is underneath in the rear. Lightness, strength and simplicity of design—benefits of magnesium—were utilized fully in this new army vehicle.

**WALKING, RIDING OR CRAWLING,** the soldier can steer and control the speed to as low as 1 mph in forward or reverse—or cruise along at the rate of 25 mph!

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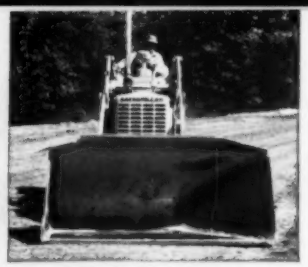
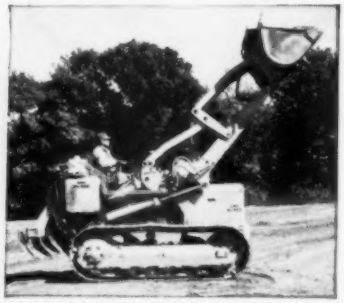
Here  comes...

the TRAXCAVATOR'S  new...

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| Bucket capacity | 1⅛ cu. yd. | 1⅛ cu. yd. |
| Overall width of bucket | 96" | 86⅝" |
| Overall height, side dump | 17' 5½" | 15' 6 1/16" |
| Overall height, level | 14' 6" | 12' 11 1/16" |
| Left side dump reach | 24½" | 25½" |

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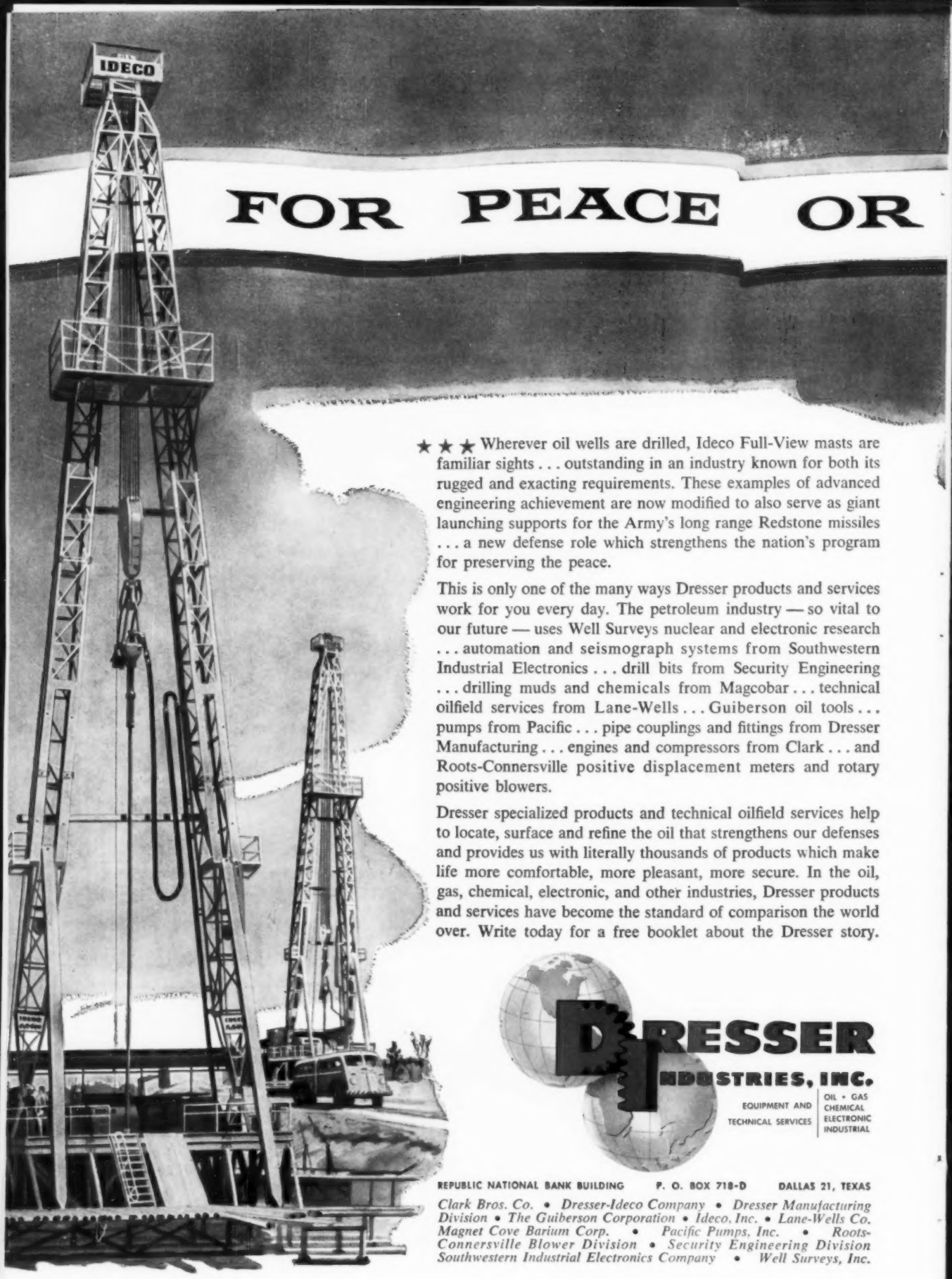


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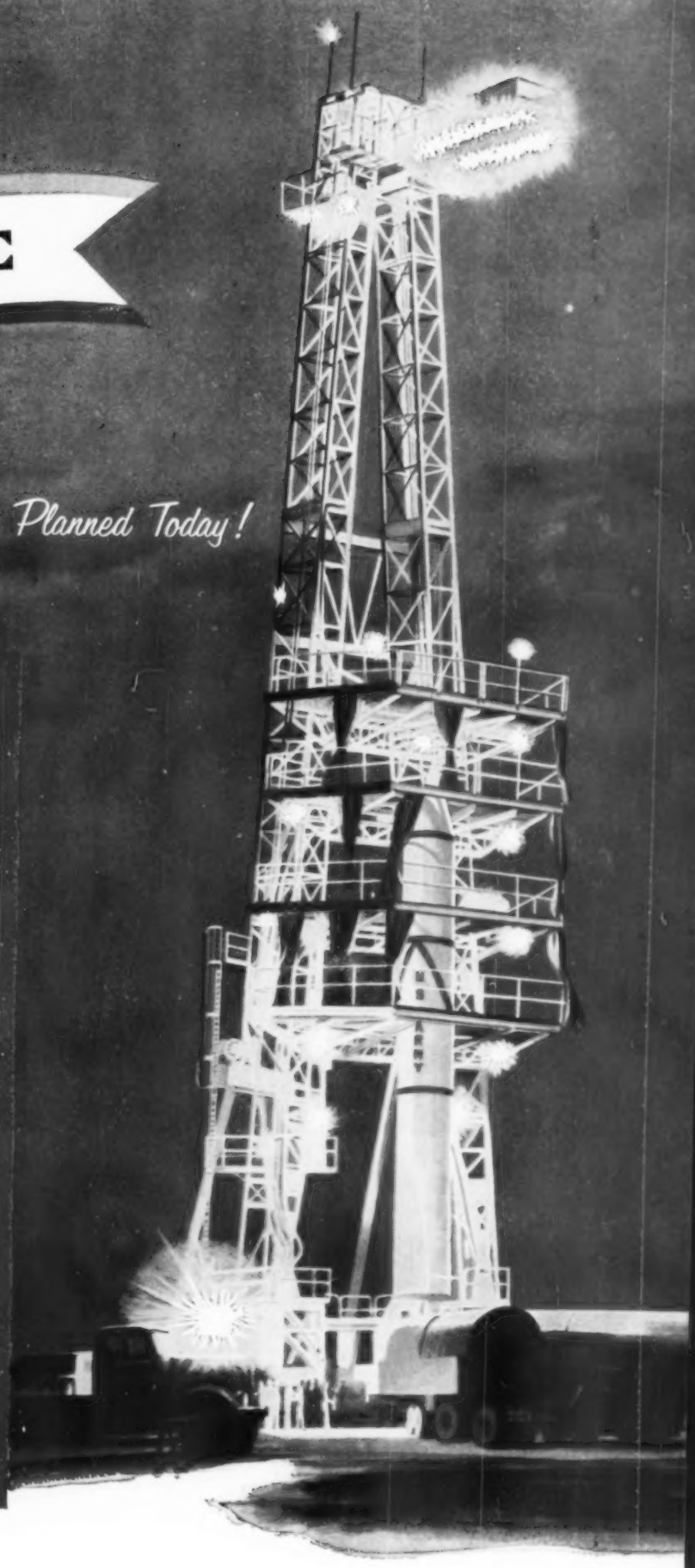
# DEFENSE

*Tomorrow's Progress Planned Today!*

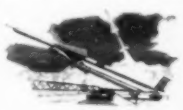


## OTHER IMPORTANT DEFENSE APPLICATIONS OF DRESSER PRODUCTS AND EQUIPMENT

Dresser Manufacturing Div. supplies flashwelded connecting rings for powerful jet engines used in military aircraft. Some types of aircraft engines require as many as 85 Dresser rings.

Roots-Connersville makes compressors and blowers for atomic submarines; gas pumps for atomic energy installations; blowers for "lifting bag" inflation to raise crashed aircraft.

Clark Turbo-Mobile power plants, rail-mounted, supply emergency electricity for Navy Yards, docks, hospitals, and major disaster areas. Unit has capacity of 6750 kilowatts, enough power for a city of 12,000.



High pressure compressors from Clark . . . instrumentation and other electronic equipment from Southwestern Industrial Electronics . . . are used in guided missiles and many other important military applications.

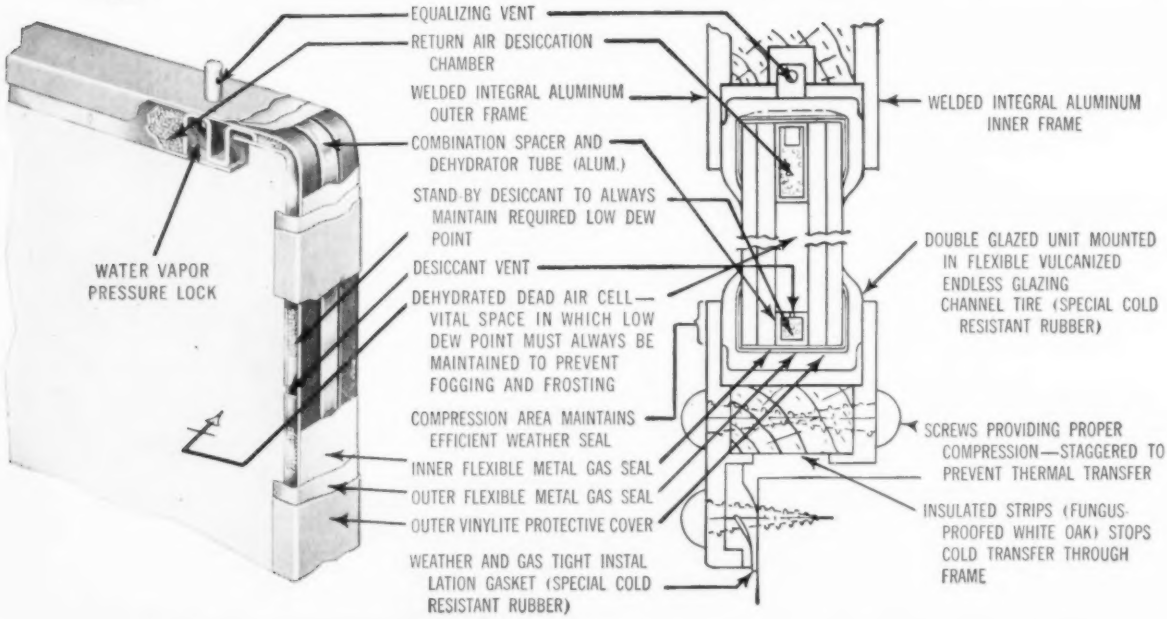
Dresser-Ideco supplies structural equipment used in military defenses, including radar outposts for our remote Arctic warning system as well as microwave, radio and television towers.

Pacific provides the Navy with Turbo pumps for ships' main and boiler feed pumps. Equipment from other Dresser companies is also used on both merchant ships and naval vessels.

# NO FOG NO FROST

*under any conditions!*

# HIGH EDWARDS ALTITUDE WINDOW ASSEMBLIES


EQUALIZING VENT
RETURN AIR DESICCATION CHAMBER
WELDED INTEGRAL ALUMINUM OUTER FRAME
COMBINATION SPACER AND DEHYDRATOR TUBE (ALUM.)
STAND-BY DESICCANT TO ALWAYS MAINTAIN REQUIRED LOW DEW POINT
DESICCANT VENT
DEHYDRATED DEAD AIR CELL—VITAL SPACE IN WHICH LOW DEW POINT MUST ALWAYS BE MAINTAINED TO PREVENT FOGGING AND FROSTING
COMPRESSION AREA MAINTAINS EFFICIENT WEATHER SEAL
INNER FLEXIBLE METAL GAS SEAL
OUTER FLEXIBLE METAL GAS SEAL
OUTER VINYLITE PROTECTIVE COVER
WEATHER AND GAS TIGHT INSTAL LATION GASKET (SPECIAL COLD RESISTANT RUBBER)
WATER VAPOR PRESSURE LOCK
WELDED INTEGRAL ALUMINUM INNER FRAME
DOUBLE GLAZED UNIT MOUNTED IN FLEXIBLE VULCANIZED ENDLESS GLAZING CHANNEL TIRE (SPECIAL COLD RESISTANT RUBBER)
SCREWS PROVIDING PROPER COMPRESSION—STAGGERED TO PREVENT THERMAL TRANSFER
INSULATED STRIPS (FUNGUS-PROOFED WHITE OAK) STOPS COLD TRANSFER THROUGH FRAME

## Only EDWARDS units GUARANTEE brilliant

## SEE THESE TESTS

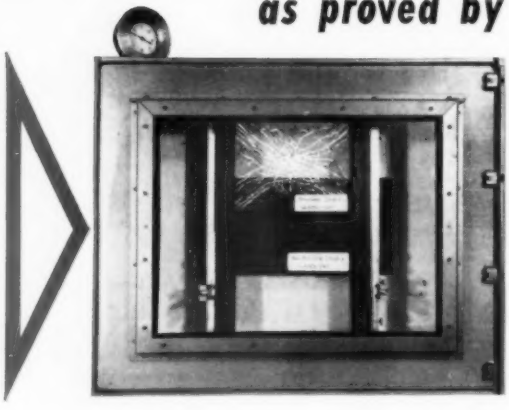
AT OUR FACTORY OR, UPON REQUEST, ANYWHERE YOU PLEASE!

### HIGH ALTITUDE TEST

**Top window** in vacuum chamber, *without* pressure release system, shattered at the equivalent of 9,000 feet elevation.

**Lower window** in vacuum chamber demonstrates the efficiency of the Edwards pressure relief system, permitting the Edwards High Altitude Window to be taken to any altitude and returned to sea level at an ascent or descent rate up to 3,000 f.p.m. without impairment of seal, bursting of glass or lowering of dew point in dead air space.

*as proved by*



# *Advanced engineering exceeds exacting requirements for Air-borne units!*

**THE PROBLEM:** A Double Glazed High Altitude Window for the armed forces which could be repeatedly air-borne to any altitude without bursting or loss of efficiency, yet always providing constantly clear vision at temperature ranges from +140° to −65° F., while affording maximum insulation against heat or cold transfer.

**THE SOLUTION:** Achieved seven years ago with the development of Edwards High Altitude Window Assemblies, a result of our years of experience in producing non-fogging, non-frosting double glazed units for the transportation system of America. Today, 100,000 of these High Altitude Windows, in a wide range of design, are meeting every requirement of the armed forces.

**EXCLUSIVE FEATURES:** The drawing at the left indicates the many advanced features which are found in no other window assemblies of this type, including:

Positive, flexible metal seal of the dead air space (between the two glass panels) which is not only air tight but, much more important, is practically water vapor tight.

Since no known seal can entirely stop the infiltration of water vapor, an ample supply of dessicant insures long unit life and always maintains the required low dewpoint of −30° to −40° F.

Pressure relief system (for air-borne requirements) vents the dead air space during the ascent of the unit and recharges the dead air space during descent without alteration of the original low dewpoint.

**FOR COMPLETE, DETAILED INFORMATION, WRITE:**

**THE O. M. EDWARDS COMPANY, INC.**
**SYRACUSE, NEW YORK**

**NEW YORK OFFICE: 50 CHURCH STREET, NEW YORK 7, N. Y.**

**EDWARDS** . . . *the Eyes of Transportation*

## TYPICAL SERVICE APPLICATIONS

AIR FORCE CRASH TRUCK

Edwards regulator drop-type windshield with heat resistant glass and *high-altitude* window assemblies.

MACHINE SHOP VAN

Edwards *high-altitude*, top-hinged, push-out window assemblies with insect screens and blackout blinds.

ARCTIC SNOW PLOW CARRIER

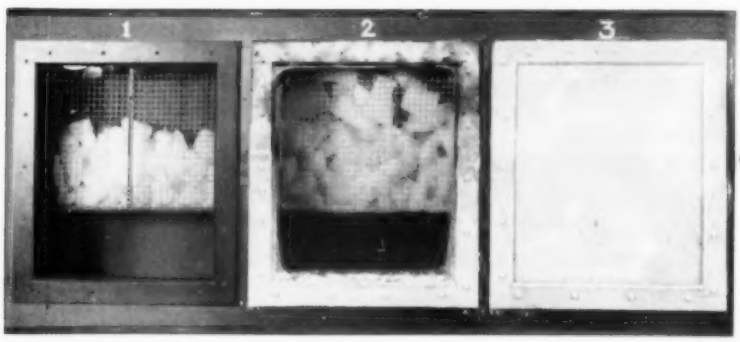
Edwards *high-altitude*, heavy-duty windshield (83 x 32) and drop-down window assemblies with regulators.

RADAR-ELECTRONIC SHELTER

Edwards top-hinged, push-out, *high-altitude* windows with inside insect screens and outside blackout blinds.

## vision at temperatures from +140° to −65° F.

## 100,000 assemblies now in Military Service




### ARCTIC COLD TEST

Here is demonstrated the ability of the Edwards High Altitude Window to insulate against the transfer of heat and cold and provide clear visibility and maximum light transfer at temperatures of −65° F. and lower. Photos left to right: (Fig. 1) Edwards High-Altitude Window. (Fig. 2) Standard double-glazed, non-insulated window. (Fig. 3) Single-glazed, non-insulated window. Results of these tests demonstrate and explain why the Edwards High Altitude Double-Glazed Window is specified by the armed services in all types of mobile air-borne equipment.

Details of missile development are secret and can only be discussed on a "need to know" basis. But when it comes to missile component reliability, it's no secret that Exide has the most experienced engineering team and the best laboratory facilities in the industry.

Exide Missile Batteries are available on short notice in a number of types and sizes. Write for catalog and engineering data. Missile Applications Department, Exide Industrial Division, The Electric Storage Battery Company, Philadelphia 2, Pa.

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"Rascal" air-to-ground guided missile
Developed and built by: Bell Aircraft Corporation
Transporter built by ACF Industries, Inc.,
as sub-contractor

SAC's new "Rascal" air-to-ground guided missile gets swift, sure handling on the ground, thanks to this **ACF**-built transporter. It's an important part of making the 13,000-pound missile truly operational, for fast ground handling when the chips are down.

As prime contractor or sub-contractor, American Car and Foundry Division of **ACF** is well equipped to handle such important jobs. Four major plants include extensive facilities for casting, welding, hot and cold forging, heat treating, cutting, forming, drawing and light and heavy assembly. The division is fully prepared to produce ordnance material from any stage of development—including such varied items as ground tanks, artillery shells, rocket sleds, armor plate, rocket engine cases, support equipment, depth charges, and many others.

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DIVISION OF ACF INDUSTRIES, INCORPORATED

***PRODUCTS FOR DEFENSE***

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## . . . even this tiny glow will actuate the super-sensitive, infra-red controls of the deadly Sidewinder missile.

Sidewinder, streaking through midnight skies on its mission of air-to-air defense, is but one dramatic example of Philco leadership in advanced infra-red technology. Conceived by the Naval Ordnance Test Station at China Lake . . . developed by Navy and Philco scientists . . . engineered and produced by Philco, the Sidewinder is a result of close weapons systems development coordination.

In the forefront of infra-red research and solid state physics, Philco is pioneering detectors which cover the entire IR spectrum including; proximity warning indicators, advanced photographic (black light) techniques, high precision industrial IR electronics, search gear and fire warning systems. Here is dramatic proof of Philco leadership in technology, capacity and flexibility. In the Wonder-World of advanced electronics . . . *look ahead . . . and you'll choose Philco.*

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**Vought Vocabulary**

# cham′pi·on: *the fighter whose record is written on aviation's most honored trophies*

Again the aviation world salutes the F8U-1 *Crusader*. The Collier Trophy, one of America's highest tributes, has been awarded to the Navy and to Chance Vought for 1957's most significant aviation achievement: development of this record-smashing jet fighter.

The *Crusader's* first triumph was the 1,015 mph national speed record that won the coveted Thompson Trophy. Next came history's first cross-continent, ocean-to-ocean, carrier-to-carrier flight. Following that flight, a *Crusader* streaked across the nation in "Operation Bullet." This 203-minute flight set an official world's record and marked the first supersonic crossing of the U. S.

The blazing performance that has taken aviation's top honors brings unmatched air combat strength to the U. S. Navy. The Vought *Crusader* is now aboard Fleet carriers . . . strengthening America's power for peace.

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**Ultra fine control** — missile launchers and radar drives have been trained and elevated with exceptional accuracy down to speeds approaching zero.

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MO-212

Target Transponder

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*(Tripod Height 4′)*

*Ground Station*
*(68″ High)*

| | Distance from Target | Accuracy |
|---|---|---|
| MISSILE TRANSPONDER | 0-200′ | ±10′ |
| | 0-500′ | ±10′ |
| | 0-3000′ | ±10′ |
| PROXIMITY SCORERS (Adjustable) | 0-100′ | ± 5′ |
| | 0-400′ | ±10′ |
| TARGET LOCATOR ACCESSORY | 0-100 mile range | ± 2% |
| | Azimuth | ± 5% |
| | To 70,000′ altitude | ± 2% |

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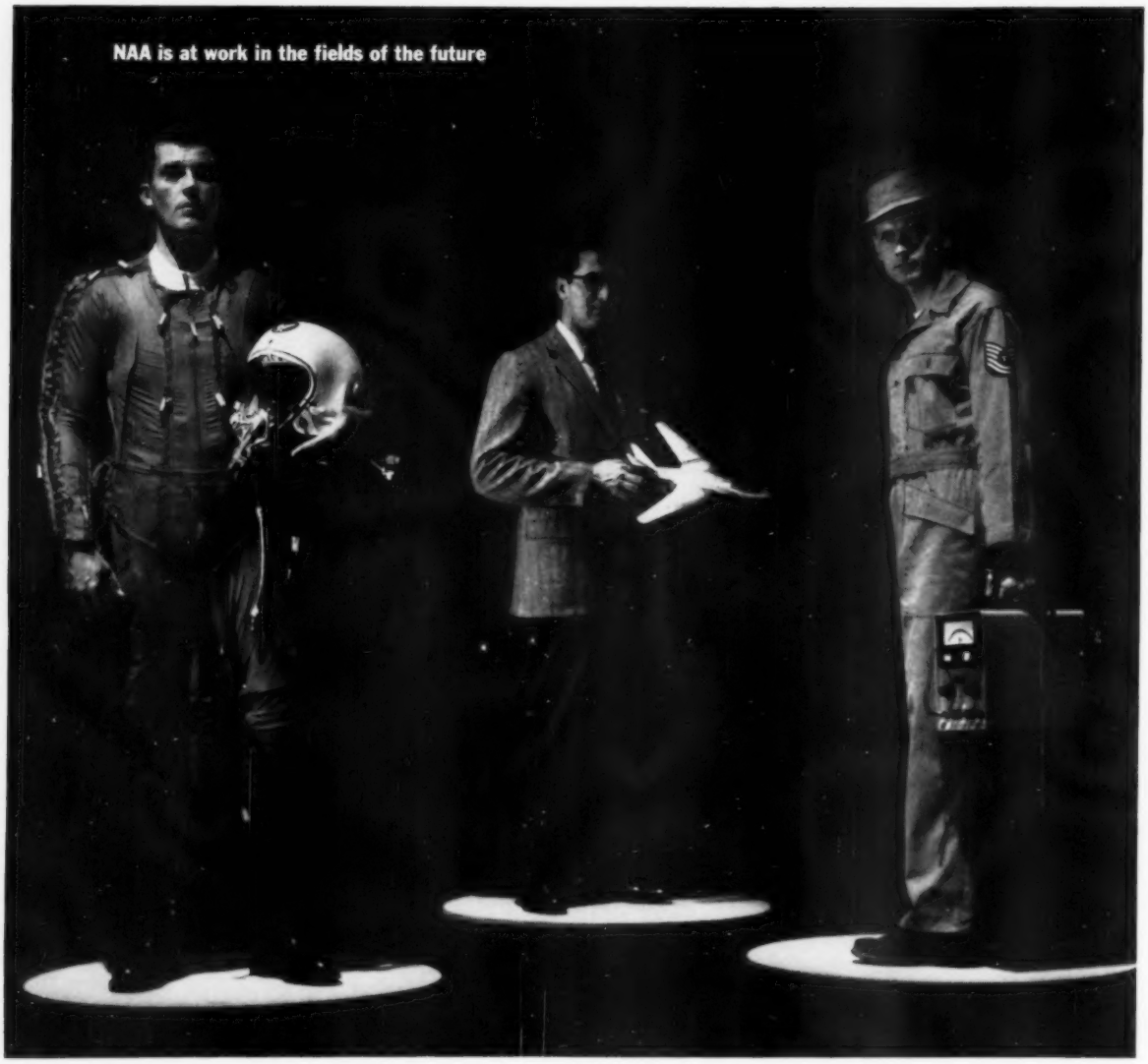



# On these three men depends America's conquest of Outer Space

Very soon now an American is going to ride a rocket ship to the edge of space—and back.

The success of this first flight—and of the others that will follow—depends on the teamwork of the men who build the rocket ship, the men who become its ground-support technicians, and the men who form its air crew. For only the closest coordination of America's industrial, technical, and military skills can achieve the conquest of space.

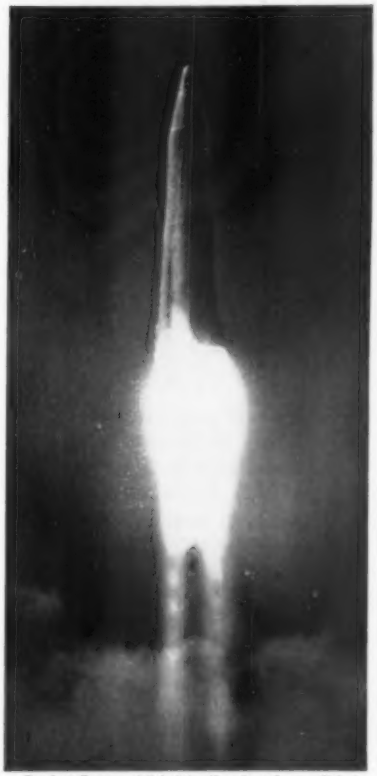
**The X-15: Space Ship No. 1**

The craft that is being readied for this first flight into space is the X-15, a rocket-powered research plane for the Air Force, Navy, and National Advisory Committee for Aeronautics. So advanced in design it might be called a manned missile, it's the forerunner of the craft that will cruise through Outer Space.

The assignment to design, build, and test the X-15 is being carried out by North American.

**Reliability Room.** Automatic control systems for America's manned and unmanned weapon systems must do their critical tasks with unfailing reliability. Even a tiny fleck of dust might impair their vital accuracy. That is why Autonetics assembles its control systems with surgical precision in this dust-free room.

**Destination: Outer Space.** A man will soon look out on space from cockpit of the X-15, rocket-powered research plane now being readied for its flight test.



**Rocket Power.** NAA's Rocketdyne Division builds rocket engines with thrust to drive Air Force's Atlas missile—or to launch an earth-circling satellite.

### Planes, brains and rockets

North American's key role in this great drive to put man into space is the result of its capabilities in the new technologies that make such a flight possible.

In supersonic aircraft, North American has had more experience than all other companies combined. In automatic controls—the electronic "brains" that will guide and navigate the X-15—its Autonetics Division has pioneered some of the most significant advances in recent years. Its Missile Development Division—pioneer of America's missile technology—is at work on an advanced air-to-ground (or space-to-earth) missile for the Air Force. And, in rocket propulsion, NAA's Rocketdyne Division is already delivering the great engines for America's major missiles—Atlas and Thor for the Air Force... Jupiter and Redstone for the Army.

### After the breakthrough

These divisions of North American are making many important scientific breakthroughs in this race to space. But even more important is the ability North American has demonstrated, time and again, to turn today's experimental flights into tomorrow's standard weapon system—swiftly, surely, and at lowest possible cost. For every breakthrough is only a new beginning; it's the *followthrough* that gets the results.

### Ground support for space

One of the Armed Services' most difficult problems in the Space Age will be the increasing workload on their expensively trained technical manpower. That is why North American is designing a new kind of simplified maintenance into all airplanes, components, and automatic control systems.

This program will pay off in three ways: more efficient use of special skills; more complete utilization of weapons; more defense for the taxpayer's dollar.

In the arts of peace, NAA's Atomics International Division has developed two nuclear reactors that show great promise as practical sources of electric power.

*Today in North American Aviation and its divisions, you'll find as potent a combination of scientists, engineers, and production men as any in American industry. Because these men are constantly forging ahead into vital new technologies, much of their work holds great promise for science and industry.*

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Slide adjustment screw, easily accessible from floor-level, makes climbing unnecessary. Cooler operating, low inertia clutch permits higher cycling and reduces maintenance to a minimum.

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# ATOMIC ENERGY

## ACCIDENT INDEMNITY

Acting under authority contained in the indemnity legislation recently enacted by the Eighty-fifth Congress, the Atomic Energy Commission will offer statutory indemnity to its major contractors, protecting them and the public against losses arising from nuclear accidents.

Commission prime contractors and their suppliers engaged in the operation of nuclear reactors or in operation of facilities such as gaseous diffusion plants or chemical separation plants who accept the offer will be indemnified up to $500 million against claims resulting from nuclear accidents. Indemnity may also be granted to other contractors engaged in activities involving the risk of occurrence of a substantial nuclear incident.

In addition, contractual assurance will be given to design and engineering contractors and suppliers of component parts that they will receive protection, as suppliers, under the statutory indemnity granted to the prime contractor who will operate the facility on its completion.

Existing indemnity provisions in agreements between the Commission and its prime contractors do not cover nuclear accidents that are caused by the fault or negligence of a subcontractor or supplier. The new indemnity offered by the Commission will provide much broader protection to the public. In addition to covering accidents for which operating contractors are responsible, it will also cover accidents for which all other persons, including subcontractors and suppliers, are responsible.

Requirements affecting licensees as to the procurement of commercial insurance or other forms of financial protection will not be applied to Commission contractors. Since all costs involved would be included in the cost of the work performed under the contract and would therefore be borne by the Commission, the Commission will not charge its contractors a fee for the indemnity.

Licensees first must provide themselves with insurance or other financial protection from private sources in amounts prescribed by the Commission, and the Commission will then indemnify them up to $500 million against claims arising from nuclear accidents which exceed the amount of private financial protection. Each indemnified licensee also pays an annual fee to the Commission based on

the thermal energy capacity of the reactor.

### NUCLEAR POWER FOR ALASKA

Plans for construction of the Army's first operating field model nuclear power plant, to be located in Alaska, were recently revealed.

The Corps of Engineers' Alaska District engineer at Anchorage was instructed to proceed with necessary action to obtain a contract for building the plant at Fort Greely, sixty miles south of Fairbanks on the Alaskan Highway. The plant will generate both electricity and heat for the post and will be modeled after the prototype plant in operation at Fort Belvoir, Va. It will answer the problem of supplying conventional fuel in a remote area.

Power furnished by nuclear fuel will be available to the military commander for the operation of modern weapons and other equipment even though normal supply lines might be disrupted by enemy action. One loading of nuclear fuel will operate the reactor for an extended period, while conventional power plants require thousands of tons of fuel for a comparable period of operation.

Basic design of the Fort Greely plant was completed recently by Alco Products Company, Inc., of Schenectady, N. Y., builder of the Army Package Power Reactor, or APPR-1, as the Fort Belvoir plant is designated.

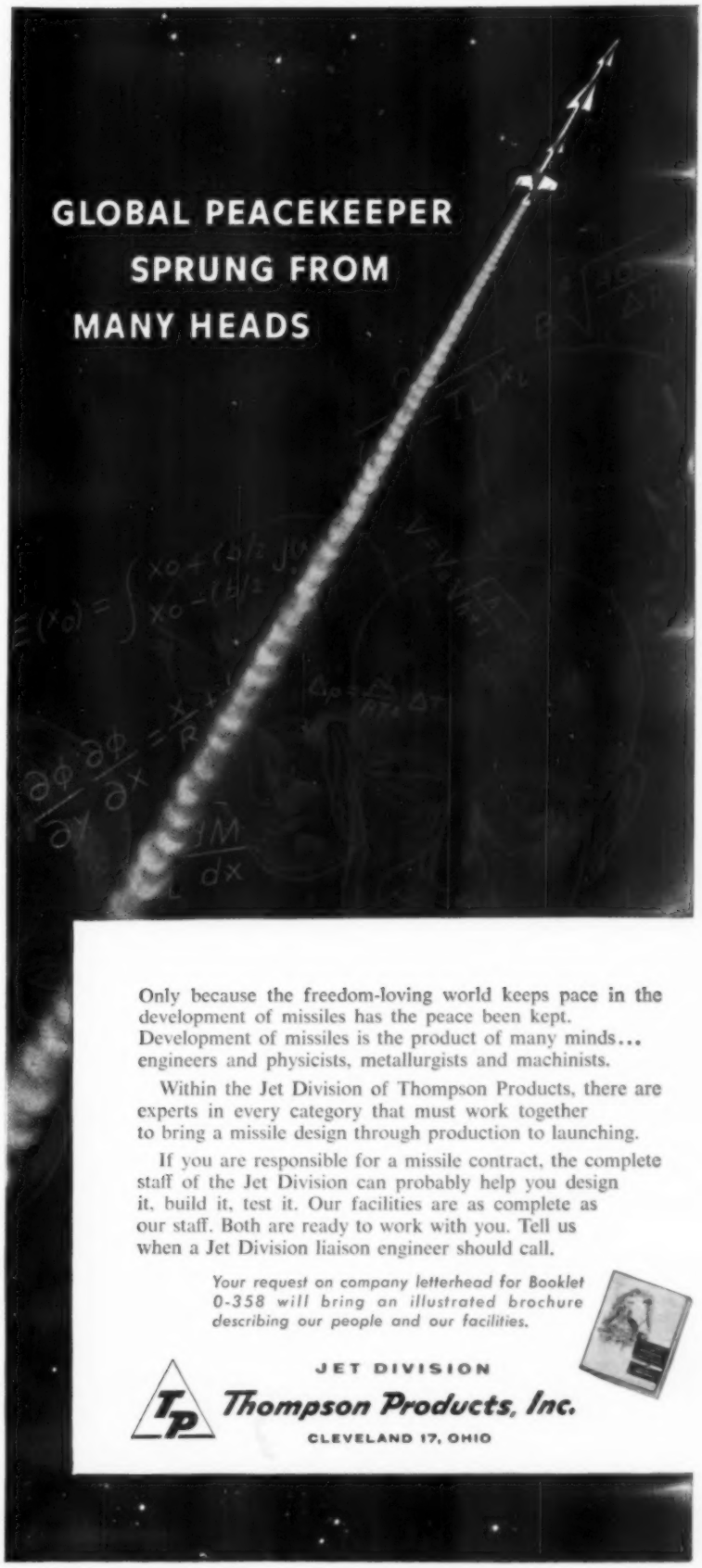
Congress has authorized a total expenditure of $6,675,000 for the project. Construction officers in the Office, Chief of Engineers, expect about $1,500,000 will be spent for procurement of "long lead" items of equipment on which manufacture must be started well in advance, even before clearance of the site is begun.

The Fort Greely reactor will produce 42,000,000 Btu per hour in steam for space heating and about 1,700 kilowatts of electricity.

The first prototype APPR-1 has been in operation since last spring at Fort Belvoir, where it feeds electricity into the post's electric system. Its primary objectives are research and development operation and training atomic power plant operators for field plants such as that to be installed at Fort Greely.

A second training cycle started at Fort Belvoir last month. The Corps of Engineers selected twenty-five enlisted men to attend the course and each of the other Army technical services was invited to send men to participate. The Air Force and the Navy each will send one officer and three enlisted men. The trainees will receive six months of academic training and six months of operational training at Fort Belvoir. It is planned to provide a

(*Continued on p. 781*)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MANY HEADS
Only because the freedom-loving world keeps pace in the development of missiles has the peace been kept. Development of missiles is the product of many minds... engineers and physicists, metallurgists and machinists.
Within the Jet Division of Thompson Products, there are experts in every category that must work together to bring a missile design through production to launching.
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Your request on company letterhead for Booklet 0-358 will bring an illustrated brochure describing our people and our facilities.
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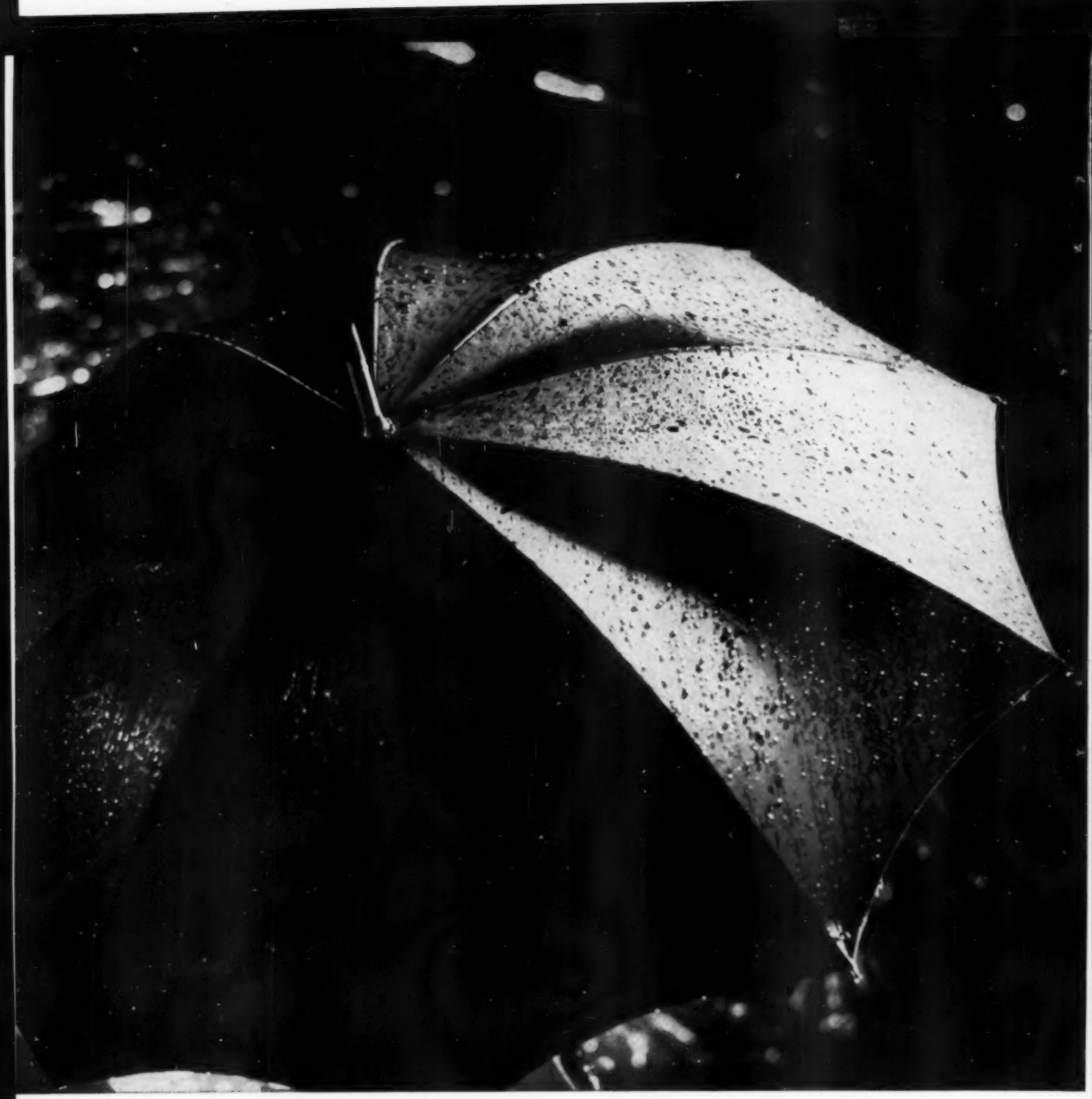

# GPE — technological bumbershoot

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The principal GPE companies cover needs of defense and industry in these areas: Audio-Visual, Automatic Controls and Automation, Aviation, Chemical Processing, Electronic and Electrical, Graphic Arts, Instrumentation, Marine, Motion Picture, Packaging, Paper, Petroleum, Photo Technology, Power Generation and Conversion, Printing, Steel, Television, Textile.

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Address inquiries to:
General Precision Equipment Corporation
92 GOLD STREET, NEW YORK 38, N. Y.



crew for the Fort Greely plant from this second group of trainees.

## REACTOR POWER DOUBLED

The experimental boiling water reactor (EBWR) at the Argonne National Laboratory of the Atomic Energy Commission, Lemont, Ill., has been successfully operated at a power level of 50,000 kilowatts of heat—more than double its design level. The 50,000-kilowatt level was attained December 23, 1957, with no change in the number or the arrangement of the fuel elements within the reactor core.

The increase in the thermal output of the EBWR is a result of ten months of experimentation. Such an increase in the thermal output would potentially increase the plant's electrical output. An increase in the electrical output would theoretically make possible a reduction in the cost of the electricity.

In the case of the experiments with the EBWR, the electrical output was increased only to 6,250 kilowatts, which is the maximum capacity of the turbine-generator portion of the plant. The amount of heat in excess of that required to produce the 6,250 kilowatts was disposed of by condensing in the plant's main condenser the excess steam that was generated.

The EBWR was designed to produce 20,000 kilowatts of heat and 5,000 kilowatts of electricity with natural circulation of the core coolant. This original design power level and electrical output were achieved December 29, 1956, shortly after the reactor was first placed into operation.

The 50,000-thermal-kilowatt operating level was achieved with natural circulation of the water coolant in the core of the reactor. The water was caused to boil at a higher than normal rate, resulting in faster circulation through the core and in a more rapid removal of heat. The plant operated in a stable manner at the increased power level. It is believed, on the basis of the tests made, that the maximum stable power of which the present EBWR is capable may be still higher than that achieved.

In addition, calculations by Argonne scientists and engineers indicate that with modifications the EBWR could produce up to 100,000 kilowatts of heat and 25,000 kilowatts of electricity. This level of operation would require the addition of more fuel and a turbine-generator and condenser of larger capacity than those of the present plant.

The EBWR is the first nuclear reactor built by the Atomic Energy Commission, having as one specific purpose the experimental generation of electricity. Power generated by the EBWR is consumed at the Argonne National Laboratory which is operated for the Commission by the University of Chicago.

## GRANTS TO COLLEGES

The Atomic Energy Commission recently announced approval of grants totaling $3,499,638 to 55 American colleges and universities to be used to expand training facilities for increasing numbers of nuclear scientists and engineers.

This brings to $6,764,388 the total amount for 91 training grants made by the Commission during the past 10 months to 68 educational institutions.

The grants are a part of the Commission's assistance program to encourage colleges and universities to establish curricula or to broaden already established study programs for the purpose of easing the shortage of trained manpower in the atomic-energy field. The funds will be applied toward the purchase of laboratory equipment.

These awards are the third in a series of grants under this program which was announced on September 4, 1956. The first award to 15 colleges and universities totaling $1,193,450 was announced on March 4, 1957. The second of the series totaling $2,071,300 was made to 21 educational institutions on May 10, 1957.

More than one hundred applications have been received since the program was inaugurated. Some proposals, received too late for evaluation, are under study.

## HOMOGENEOUS REACTOR

The Homogeneous Reactor Experiment No. 2 (HRE-2), an experimental power reactor of the Atomic Energy Commission, has been placed into nuclear operation at the Oak Ridge National Laboratory. The reactor achieved criticality at 6 p.m. on December 27, 1957, becoming the sixth experimental or full-scale power reactor to go into operation in the United States during 1957.

The reactor is of the aqueous homogeneous type, utilizing a solution or suspension of nuclear fuel in water which serves as coolant and moderator. The homogeneous reactor is one of the five reactor types included in the Commission's original civilian nuclear power reactor development program adopted in 1954.

The HRE-2 is a 2-region reactor consisting of a core filled with a heavy-water solution of uranyl sulfate surrounded by a blanket containing heavy water as its initial loading. The fuel solution is pumped under pressure through the reactor vessel where it is heated by uranium fission, then through heat exchangers where the heat is released to produce steam. The steam can be used to drive a conventional turbine-generator to produce electricity.

The reactor plant includes chemical processing equipment for purifying the irradiated fuel solution by continuously removing corrosion and fission products.

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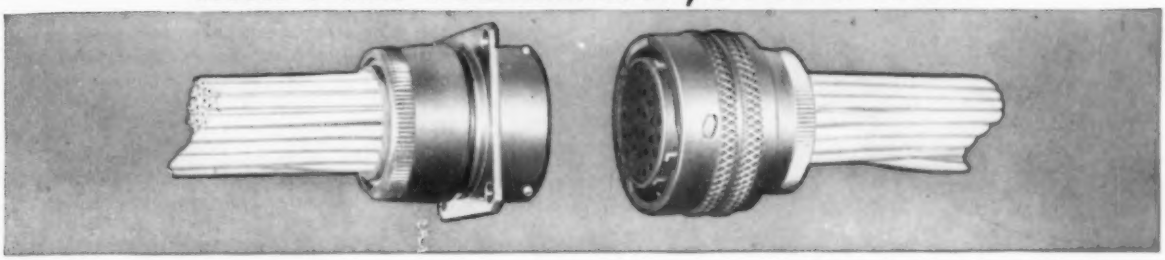

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*Commanding General, Army Ballistic Missile Agency*

**Dr. Wernher von Braun**
*Director, Development Operations Division, ABMA*

## THE ARMY SATELLITE TEAM

*The civilian and military leaders who head the organizations which jointly launched Explorer I—America's first space satellite—on January 31, 1958, from the Air Force Missile Test Center at Cape Canaveral, Florida*

**Dr. William H. Pickering**
*Director, Caltech Jet Propulsion Laboratory*

**Maj. Gen. Holger N. Toftoy**
*Commanding General, Redstone Arsenal*

# Ordnance in Outer Space

*Army teamwork is responsible for the launching of Explorer I*

THE Army's missile team has restored the Nation's mental equilibrium. The alarms and frights of the past four months seem to be forgotten as we pick up the fragments of our shattered self-esteem and dash off to conquer the moon.

The country is elated and proud of the leaders who directed the Jupiter-C-Explorer satellite project. In hailing these leaders, we do not overlook the large team of scientists and industries who were integrated in the task to launch a satellite.

The launching was an amazing feat in the compression of time. In early November, Army Ordnance received a go-ahead which seemed to be reluctantly given. In less than three months, Explorer was orbiting. Such fast action was possible, perhaps, because the larger and more complex components were on the shelf, either for active missile developments or having been stored away when it was decided long ago that a satellite program would be kept separate from military missile projects.

Nonetheless, to select the most desirable satellite form, decide upon and install the instrumentation, modify a Redstone missile, match three more stages for the desired impulses, and perfect the entire assembly, was a herculean task to accomplish in the allotted time.

THE Army Ballistic Missile Agency, backed by the Redstone Arsenal and the Jet Propulsion Laboratory of California Institute of Technology, an activity supported by Army Ordnance, make up a sure-fire team.

The four-stage rocket was a Jupiter-C test vehicle designed for nose-cone-reëntry tests and modified to carry the satellite. ABMA produced the first stage—a modified, specially fueled Redstone missile. The next two stages were clusters of eleven and three solid-propellant rockets, respectively, designed by the Jet Propulsion Laboratory. The fourth stage, a single small rocket attached to the satellite, was also developed by the Laboratory. Initial boost carried the vehicle up more than 200 miles after which the last 3 stages were fired in orderly succession to bring the satellite to its orbiting velocity of about 18,000 miles an hour. Dr. Ernst Stuhlinger, ABMA chief of research, had the honor of pushing the firing button.

In addition to the leaders pictured opposite, other scientists on the team besides Dr. Stuhlinger include: Dr. J. E. Froehlich, project director for JPL; Dr. Kurt Debus, ABMA test director for Jupiter-C; and Dr. James A. Van Allen, State University of Iowa, who developed the cosmic-ray counter.

When such brain power can be teamed up with understanding technical men from industry and government and with leaders who can steer projects out of political pitfalls and around financial roadblocks, there is no limit to the success such a team may achieve, provided they are permitted to work in a proper climate. Even the most promising program of the most capable scientists backed by the strongest industry can crumble in frustration if there are too many "overseers," vacillating directives, or lack of decision.

Perhaps the Army missile team was fortunate that higher echelons were heavily engaged in explaining to legislators why we were outsputniked. This meant fewer of the top layers were as free to bother the working team.

THE great success of the Army missile team is worthy of careful study by planners and administrators. In the vast fields of missile progress and the conquest of space, the American Ordnance Association will continue its support of the Science-Industry-Ordnance Team as typified by the one led by Maj. Gen. J. B. Medaris, Dr. Wernher von Braun, Maj. Gen. Holger N. Toftoy, and Dr. William H. Pickering.

**Maj. Gen. J. B. Medaris, commanding the Army Ballistic Missile Agency and leader of the "satellite team," announced that the Army was working on "other more sophisticated programs." Earlier, in talking to Senators, General Medaris reportedly said: "Give me clearly defined objectives, adequate manpower and funds for one year ahead—and then let me alone."**

**This brought to mind the remarks of Dr. Wernher von Braun, technical director of ABMA, before Congressmen investigating progress on the Jupiter missile. After stating that he attended two committee meetings a month at the Pentagon, he was asked: "Were these committee hearings constructive?"**

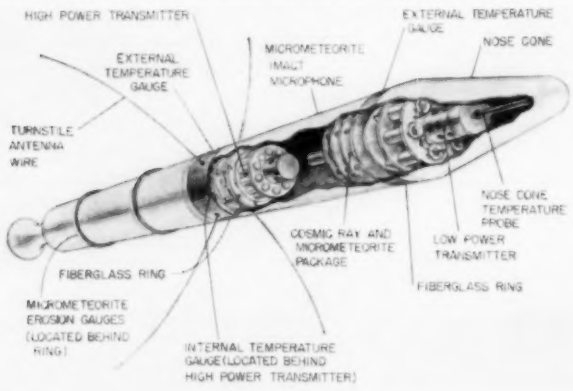
**Dr. von Braun replied: "Sir, I think we have too many committees in this area. There is a difference between a committee that evaluates something and a committee that continuously interferes with executive operations. The mechanism in the Pentagon is something like this: On practically every level there is an advisory committee advising a particular Assistant Secretary as to what is right and what is wrong, and since that man wouldn't make a decision without advice from his committee, you can't bypass the committees."**

**The next question: "Was this system impeding you in your work?" Answer: "Yes, definitely."**

Above, left to right, John Small, Dr. J. E. Froelich, Dr. Albert R. Hibbs, Karl W. Linnes, and Walter K. Victor of the Caltech Jet Propulsion Laboratory inspect the satellite.

At ABMA, key missilemen examine a satellite. Left to right: Eberhard Rees, W. A. Mrazek, Dr. W. Haeussermann, Maj. Gen. J. B. Medaris, Dr. W. von Braun, Dr. Ernst Stuhlinger.

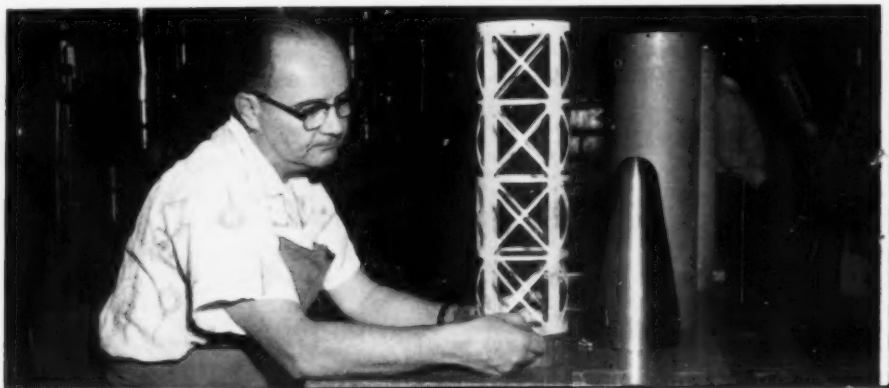
Jesse Cunningham, Jet Propulsion Laboratory Technician, above, machines the fiberglass lattice sleeve which holds instruments inside the satellite, some of which are indicated in the drawing below.




C. J. Finnie, below, installs two radio transmitters in the completed instrument sleeve.

George Ludwig, below, prepares to test a satellite component on the "shake table" at JPL.

George Scherer, below, technician at the Caltech Jet Propulsion Laboratory, inspects the fiberglass instrument sleeve. At right are steel casing and nose cone.

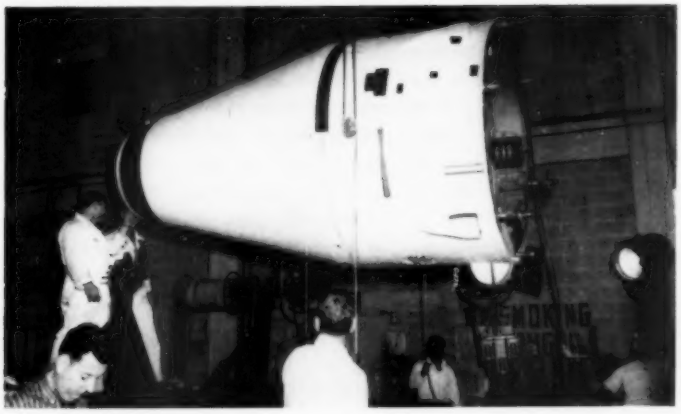


Technicians at ABMA, above, mount the satellite in the high-speed rocket stages.

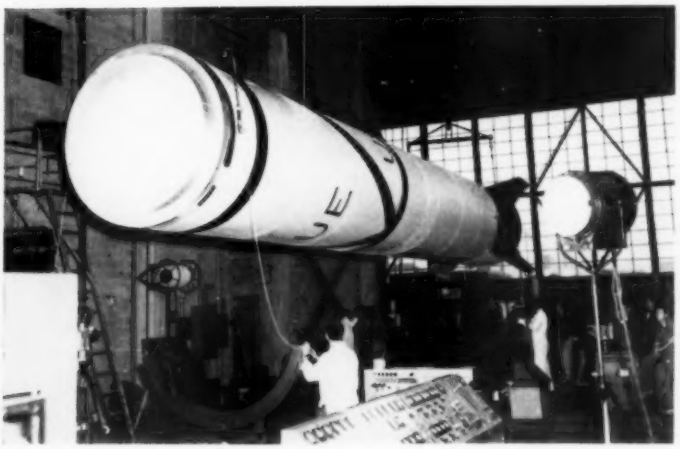
## LAUNCHING OUR FIRST SATELLITE

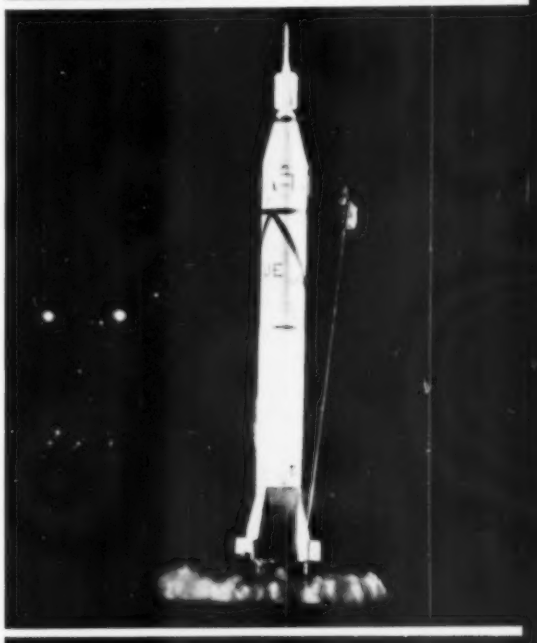
At 10:48 p.m., EST, on January 31, 1958, one hour and 13 minutes before the second birthday of the Army Ballistic Missile Agency, the Army's missile team launched the first United States space satellite from the Air Force Missile Test Center at Cape Canaveral, Fla.

The final stage of a Jupiter-C rocket, the satellite, named the Explorer, weighs 30.8 pounds, including an 11-pound payload of instruments which broadcast information on space conditions to earth as the satellite circles in orbit.



The highly instrumented nose cone of the Jupiter-C, above, is readied to be assembled to the main booster stage, below, at the Army Ballistic Missile Agency. At right the completed vehicle takes off on historic flight.





# The Future of Defense

*As a democratic nation we have an obligation to keep our own people properly informed of threatening dangers and our plans to combat them and to keep the confidence of the free world in our leadership*

Hon. Donald A. Quarles

*Deputy Secretary of Defense*

THE Soviet launching of the sputniks and the rattling of their ballistic armor have been the sparks, or perhaps I should say the lightning strokes, that have fired the public conscience and brought this subject of national defense back into first place in the minds of our countrymen. In this sense, as in the case of some other noteworthy events of the past, the sputniks may well have been a blessing in disguise. They are at the same time a symbol and a warning.

We would do well to take a hard analytical look at Soviet cold-war methods. A ruthless dictatorial government has complete freedom of action. It can present the facts; it can so pervert the facts as to falsify them; or it can suppress the facts. Moreover, it can choose between these alternatives without respect for the opinions of its own public, considering only the effect of its announcements upon the opinion of the outside world.

Obviously, in our democratic way of life we do not have these alternatives. Not only must we stick to the facts but we must also present them with such objectivity that they will meet two serious obligations. The first is the obligation to keep our own citizens properly informed of the dangers our country faces and the actions we should take to counter these dangers. The second is the obligation to keep the confidence of the free world in our leadership—faith in our strength and our determination to maintain our collective-security position in the struggle with the Communist bloc.

These two obligations at times seem to be in conflict with each other. Our leaders have an obligation to steer a very careful and objective course in order to discharge both obligations properly. Threats to our national security and our needs for resources to meet these threats must not be overstated, because overstatements would tend to destroy the confidence that our free-world friends and allies place in us and thus to undermine the very position we are determined to preserve.

Similarly, understatement of these threats and needs might breed complacency at home, which is also obviously dangerous and unacceptable. It is very difficult to be completely objective under these conflicting pressures.

Senator Lyndon Johnson expressed this in a colorful way when he said that this is no time either for hysteria or a siesta.

Aside from our public-relations problems I suppose there has never been a time when the technical and organizational problems of our business have changed so rapidly and so drastically. Not only have the rapid advances in science and technology caused revolutionary changes in the requirements for national defense, but we also must be constantly concerned that future technological break-throughs might in a very short space of time cause further and very significant changes.

OUR national policy must recognize these facts of life and must be flexible in its adaptation to them. At the same time we realize that these rapid changes work hardships on many industries that have shown great energy and skill in producing our munitions of war. Here, too, proper maintenance of our defense posture calls for flexibility so that new knowledge may be applied quickly to increase the effectiveness of our armed forces.

We must also continually remind ourselves that mere numbers, as such, are no longer a complete index of military strength. Actually, numbers of units may tend to decrease while at the same time we are, in fact, increasing our military effectiveness. Of course, the true measure of our strength is the ability of our forces to perform their missions in the face of the opposing Communist forces.

In his autobiography, "The Education of Henry Adams," the author in 1905, while thinking of the inexhaustible energy of our universe, wrote: "At the rate of progress since 1800, every American who lives into the year 2000 would know how to control unlimited power. He would think in

complexities unimaginable to an earlier mind. He would deal with problems altogether beyond the range of earlier society. To him the nineteenth century would stand on the same plane with the fourth—equally childlike—and he would only wonder how both of them knowing so little, and so weak in force, should have done so much. . . ."

IN these observations, the only error which Henry Adams made was that man's control of vastly increased power has come half a century earlier than he prophesied.

We entered World War II with weapons which were for the most part improved versions of World War I weapons. The increased emphasis on technology here and abroad during World War II resulted in the development of jet aircraft, of ballistic missiles of moderate but alarming range, and of atomic weapons of undreamed of potency.

Since World War II the development of vastly more destructive hydrogen bombs, guided missiles, high-performance aircraft, and greatly improved naval vessels has magnified manifold the potential dangers of any future war.

On the horizon, nuclear propulsion, satellites, intercontinental ballistic missiles, and even missiles to intercept missiles give us plenty to occupy our thoughts and efforts for some time.

Prior to these revolutionary changes we always have been able to plan on a year or two to mobilize the vast war potential of our country. The luxury of this time to mobilize has been lost. In large measure our security now depends on the forces and weapons we have in being. The Soviets alone have over 170 divisions, more than 20,000 military aircraft, and over 500 submarines. And this, of course, is not all. It is the breadth of their scientific effort and the rate at which their technology is advancing that are our most serious concern.

Their successful launching of satellites in orbit around the earth has been, as mentioned earlier, a symbol of their progress. It also has served as a warning to alert our people and to tighten the ties between the free nations of the world. We now see a rededication to free-world collective security, with the hope of greatly increased sharing of scientific, technical, and military knowledge and tasks among the allies. Our resources are great, but in these times of rapid technological change the free peoples of the world cannot afford the luxury of doing the same research and development job several times.

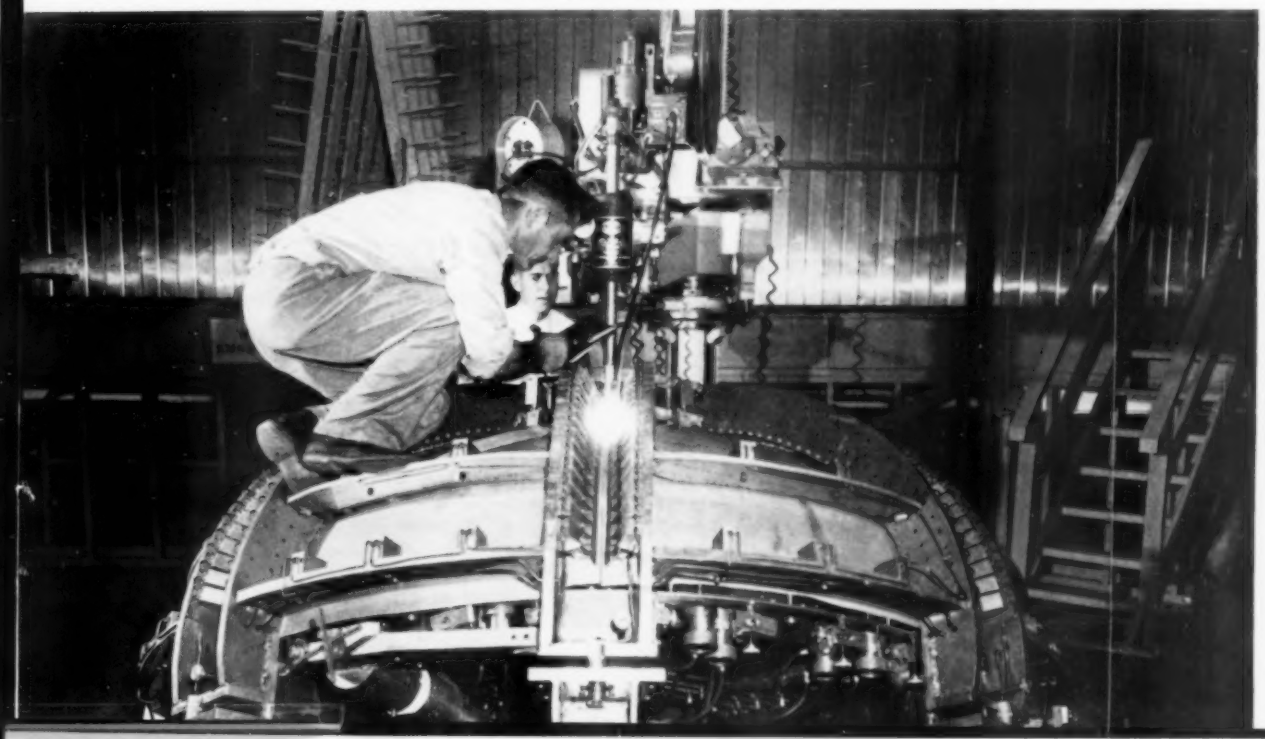
RECENT dramatic events again emphasized that we must do all in our power to strengthen the NATO alliance. All members of the alliance must be determined, in the years ahead, to develop an even more effective teamwork in order to secure an adequate defense. Improved teamwork will require that both military and scientific assets be more effectively pooled for the common good.

Our laws and regulations governing the transfer of classified information are being reëxamined with a view to relaxing restrictions where this can be done properly in the enlightened interest of our national security.

IN approaching this national decision to increase greatly the free interchange of scientific and technical information, we must remember that this is not a one-way street. There is much for the United States to gain from such an exchange. While our position in the world of science has improved greatly in the last two decades, we need only to remind ourselves of the important contributions that have been made by men like Faraday, Maxwell, Marconi, Einstein, and Fermi in order to appreciate our interdependence with our allies in these fields.

We must also remember in this connection that the intentions and objectives of the Communists have never changed. Their goal is world domination. In the last ten years they have confronted us with many startling de-

**Special equipment is needed to weld part of the fuel tank for the Titan intercontinental ballistic missile.**



velopments. Not only have the Soviets broken our monopoly in atomic weapons, but they have made rapid advances in the militarily important fields of aëronautics, electronics, and missiles.

FOR some time they have had the means of delivering weapons of untold destructiveness against our homeland. Moreover, our continental strategic bases would have to be the first targets of any all-out war they might decide to launch. Thus there is no uncertainty about their objectives, their capabilities, or about the priority of our bases on their target list.

Since the advent of the Soviet satellites there has been much talk in the press, on television, and by people on the street about the need for doing something to counter the Soviet satellite propaganda. In my mind, the most important significance of their satellites lies in the indication they give us of the state of their scientific work in this field, with the clear evidence that they have laid a very strong foundation for their future scientific efforts. Quite logically, then, our first reaction was to see the sputniks mainly as a challenge in science and technology, and to reexamine the fundamentals of our position in this area. Near term, this calls for a program for best utilization of our available scientific resources. In a longer-term sense it calls for a broader educational foundation for scientific progress.

The emphasis which the President has given these matters in his recent speeches and his appointment of Dr. James R. Killian as his special assistant in mobilizing science to defense are good indications of the seriousness with which the matter is viewed. Let me say that we in Defense are pleased and heartened by Dr. Killian's appointment, and we are already profiting by working closely with him.

There are a number of other actions that have been taken recently that might be regarded as reactions to satellite launchings and ballistic missile rattlings. Let me remind you, though, while the recent Russian successes and claims have dramatized the need for such actions, they are really being taken not just to counter sputniks but to counter the Soviet threat to the free world which existed before sputniks, has existed since, and will continue to exist for an indeterminate time into the future.

A Defense decision of importance to the United States was announced by Secretary Neil H. McElroy when he authorized the production of both the Army-developed Jupiter and the Air Force-developed Thor intermediate-range missiles. We would rather have had time to select one after further testing. Such a course would have been less costly. The course adopted, however, was in line with findings of our scientific advisers, and it will give us an added degree of assurance that we will have the earliest possible operational capability.

We have agreed on arrangement for providing intermediate-range ballistic missiles to the United Kingdom within the coming year. There is also under consideration provisions of IRBM's for other NATO countries. The Air Force has the responsibility for the deployment of intermediate-range and intercontinental-ballistic-missile units and has assigned this responsibility to the Strategic Air Command.

Having in mind the key rôle of retaliatory forces in our defense posture, a program to increase the striking power and decrease the vulnerability of our strategic bases has been under way for some time. We are now accelerating important phases of this program, such as the provision of additional dispersal bases and alert arrangements on SAC bases to decrease reaction time, and the better deployment of tanker aircraft. Each month a new squadron of the world's finest strategic bomber, the B-52, is rolling off the production line.

The Distant Early Warning Line along the Arctic shoreline of our continent went into operation on schedule last summer. We are already working on extensions of the line to the east and the west, as well as on plans for increasing its coverage.

Programs are under way for modernizing both organization and equipment of our ground forces and for further most significant advancements in our naval surface and submarine forces. In fact, the Department of Defense and appropriate committees of the Congress are reviewing all aspects of our national defense establishment. I can assure you that far from complacency there is a great sense of urgency on the part of the many dedicated individuals who are devoting themselves to these matters in the military establishment.

AS we continue our efforts to perform the task of national defense, the support provided by your organization is invaluable. If one studies the aims and purposes of the American Ordnance Association, he is immediately aware of the close association of these aims and goals to those which were so clearly stated by President Eisenhower in his two recent television addresses to the country. The attainment of your stated aims and purposes is of vital importance to our Nation. May I earnestly request that you redouble your efforts toward the maintenance of a strong, prepared United States.

I would like to conclude by quoting from President Eisenhower's speech at Oklahoma City, which seems to me to be an excellent summation of the things I have attempted to express.

"The goal we seek is peace with justice. This can come to our Nation as it comes to all. The world's hope is that the Soviets will coöperate with all the rest of us in achieving this goal. Our defense effort, large as it is, goes only far enough to deter and defeat attack. We will never be an aggressor. We want adequate security. We want no more than adequacy. We will accept nothing less."

*This article and all the following feature articles in this issue are based on addresses incident to the sessions and seminars of the Thirty-ninth Industrial Preparedness Meeting of the American Ordnance Association held at the Waldorf-Astoria, New York City, December 4, 1957. The seminars dealt with the subjects of "General Requirements for Limited War," and "Research and Development Objectives for the Improvement of Limited War Capabilities."*

# The Navy Today

*Our sea force is using the latest technologies and incorporating the most modern weapons into its ships and aircraft in order to retain its eminence as a powerful instrument of national policy*

Rear Adm. R. E. Rose

*Assistant Chief of Naval Operations, Fleet Operations and Readiness, Washington, D. C.*

FOR the past several weeks there has been great discussion of rockets, space ships, the problems of guidance and reëntry of missiles. Let us not forget during our missile debates that the Communists are continously trying to deepen the buffers around Russia. The nibbling on the free-world perimeter never lets up—the cold war always threatens to become hot. Perhaps it will, one of these days, if the U.S.S.R. or Communist China ever gets the idea that the United States has grown militarily soft or has not soundly assessed the threat against us.

The basic problem of our national strategy therefore, is how to preserve and protect ourselves and a worldwide system of alliances from the threat posed by the Soviet Union.

Stemming from this central problem are others: the problem of deterring general war; of preventing or at least controlling local war; of preventing further loss of peoples and territory to the Communist sphere of influence. These may seem like separate problems and demand different measures for their solutions, but in another sense they are so closely related as to be really parts of the same problem. The failure of one cancels the success of all others.

THIS means that we must maintain the capability to carry out certain basic military tasks. There is no question of relative priority—we have to do them all, and do them all adequately.

We need a long-range air strike capability. We need a reasonable amount of continental defense. We need the protective shield which is given to us by well-equipped ground forces in place overseas. We need naval capabilities to apply the mortar of sea power to our alliances. We have to be ready for the military demands of the cold war, for localized conflicts, and for the possibility of terrible general war with the Communist bloc.

Seapower preconditions all strategies. It is a sort of permissive agent without which little else can be accomplished.

Controlling the seas means that we can project our national power in many combinations to the maritime frontiers of Eurasia. It means that the strength of the free world can be combined. It means that deterrents to war are shipbased and dispersed in the vast ocean spaces. It means reducing the chances an enemy has of knocking us out. It means reducing his temptation to try it. It means his continued sensitiveness to his maritime frontiers.

We in the Navy consider that our attack carrier strike force is the core of our naval superiority. The attack carrier strike force can fight all kinds of wars. In the event of a surprise attack on the United States this force at sea may fare very well in contrast to forces on land, and in this sense carrier forces are retaliatory forces, complementary to the Strategic Air Command.

Fundamentally, however, they are trained for precision work. They are designed and made ready to turn off threats to our control of the seas at the threat spigots.

One of the world's most distinguished soldiers, Field Marshal Montgomery, said three years ago: "The navies whose work lies in the Mediterranean or European waters do not need their own air forces. We should not build any more expensive aircraft carriers."

But Field Marshal Montgomery has completely changed his views in the last three years, and in a speech before the British Navy League on October 21, 1957, he said:

"Three-quarters of the surface of the world is water. It is clear from what I have just said that the Western Alliance must have the free use of the water areas in peace and in war. The teaching of history is that from the days of early Rome the nation which had control of the transit areas and seas in the end prevailed. . . . Today, control of the seas is a matter for ships and aircraft—all operating under naval direction and control. To carry out this task efficiently the Navy must have *its own* aviation. Furthermore, the aircraft carrier of the Navy is the indispensable mobile airfield of modern armed forces.

These mobile airfields are greatly valued by the Army."

These are strong words from the man who has been the Deputy Commander of SHAPE since its inception.

Fifty years ago one of the greatest events in the history of the United States Navy took place when Theodore Roosevelt sent the "Great White Fleet" on its trip around the world. The sixteen coal-burning battleships, which left Norfolk in December 1907, were propelled by triple-expansion reciprocating engines and bristled with guns of many calibers. These were modern ships at the end of a great era—the changeover from sail to steam, the advent of radio, and the ascendancy of the battleship.

TODAY our Navy is in an era of guided missiles, jet airplanes, and nuclear power, all of which had their origin within the last decade. As the cruise of the Great White Fleet in its day indicated the power of the United States Navy, so likewise today our new developments have shown the world our leadership in technical progress and power.

My first example of the Navy's technical progress will be one which is well known—the nuclear-powered submarine, the NAUTILUS. On her first charge of reactor fuel she steamed over 60,000 miles. More than half this distance was covered while the NAUTILUS was completely submerged.

For a conventional submarine to have traveled the same number of miles would have required approximately 2 million gallons of fuel oil and refueling by a tanker approximately 20 times.

The NAUTILUS has scored another first. Recently she completed an arctic cruise to enable scientific and operational personnel to obtain data on under-ice conditions, oceanographic studies of currents, and cold-weather operations of equipment and machinery. The NAUTILUS spent a total of 5½ days under the arctic icepack, traveling more than a thousand miles while gathering these scientific data.

In addition to the NAUTILUS we have two other nuclear-powered submarines —the SKATE, which was commissioned the latter part of December, and the SEAWOLF, which is in commission now. In addition to these three true submersibles, we have approved sixteen additional nuclear submarines up through the 1958 shipbuilding program.

The largest and most important nuclear-powered surface ship so far authorized for construction is the attack aircraft carrier which will be built by the Newport News Shipbuilding and Drydock Company. The unrefueled cruising radius of this ship for all practical purposes will be infinitely greater than that for a conventional carrier. It will be capable of maintaining high speeds for days on end.

The first nuclear-powered surface ship to be authorized was included in the 1957 building program. This is a guided-missile cruiser, the LONG BEACH, whose keel was laid in December at Quincy, Mass. The Navy's first all-guided-missile ship, she will have an entirely new and much more powerful radar, similar to that on the nuclear carrier. She will carry two Terrier guided-missile launchers forward and a Talos missile launcher aft and will have no guns except the saluting battery.

We are also designing a nuclear power plant for another type of ship which will be very important to us in antisubmarine warfare. This ship, which we term a frigate, is midway in size between a destroyer and a cruiser. We hope to be able to start construction of this frigate in the near future. She will be equipped with missiles and antisubmarine-warfare weapons to protect our naval task forces against air and submarine attack.

Let us now look at the Navy's guided-missile program. Because of the mutiple missions of the Navy and its versatility to accomplish its many tasks, we must be in the missile business across the board, so to speak. That is, we have requirements for missiles in all four major categories—surface-to-air, air-to-air, air-to-surface, and surface-to-surface. All the missile projects necessary to meet these requirements are on schedule and in most cases are exceeding expectations in performance.

Now, however, I want to tell you what we actually have in the fleet—what we have operational and available now for use by ships, submarines, and aircraft squadrons. We have missiles which are being prepared, checked out, and fired by our own Navy crews without technical civilian assistance.

The Navy has two operational antiaircraft missiles. First is the Terrier, a missile which is about fifteen feet long, exclusive of its booster, and weighs several thousand pounds. The Navy now has three operational ships equipped to fire the Terrier missiles. These are the cruisers BOSTON and CANBERRA, and the destroyer GYATT.

Our next antiaircraft missile is the Talos which is a long-range, surface-to-air guided weapon with speed and altitude capabilities needed to cope with the present and projected threat from aircraft and missiles. Talos uses high-explosive or nuclear warheads and can be employed against enemy ships and shore-bombardment targets as well as against high-performance aircraft and missiles. The first cruiser converted to launch Talos, the GALVESTON, will join the fleet this year.

We also are developing the Tartar missile which will be small enough to go into destroyers and the secondary batteries of large ships, yet have more performance than the original Terrier.

OUR Navy fighter squadrons have two missiles—Sidewinder and Sparrow. Already we have aircraft fighter squadrons equipped with each of these missiles deployed in each fleet. These are not paper squadrons—they are in operation aboard our carriers ready for action.

Sparrow I has been in the fleet for over a year. It is powered by a solid-propellant rocket motor and is small enough to be carried by fighter and attack airplanes. With a speed of over 1,500 knots, it has proved by test its ability to intercept and destroy targets even under extreme evasive action.

Our second air-to-air missile which is now operational and is on board fleet units at sea is the Sidewinder.

This missile provides the fleet with a rugged, relatively inexpensive weapon capable of operating against high-performance aircraft. The Sidewinder is extremely accurate and can destroy enemy fighters or bombers from sea level to altitudes of over 50,000 feet.

In the surface-to-surface category, the Navy can make a particularly significant contribution to our total defensive military readiness. The surface-to-surface missile lends itself either to surface ship or submarine employment. It is the submarine employment, however, which bids fair to pay the greatest dividends. This stems from the fact that, with essentially no supporting forces, guided-missile submarines, either singly or in groups, can operate in the face of strong defenses in widely dispersed areas.

THE surface-to-surface missile, Regulus I, which resembles a sweptwing fighter about thirty feet long, was developed by Chance Vought Aircraft, Inc., under the sponsorship of the Navy and was designed for launching from submarines, surface ships, and shore bases. Tactically, this weapon will be used against appropriate land targets and in amphibious warfare by the Marine Corps and the Navy. Its payload is an atomic weapon, and, at present, carriers, cruisers, and submarines can be deployed with this operational missile.

An advanced successor is the Regulus II which is a 1,000-mile-plus-range missile with speeds in excess of Mach 2. The Regulus II is destined to go aboard submarines such as the Navy's first nuclear-powered missile submarine, the U.S.S. HALIBUT, now under construction, and to fit into the present weapon-systems concept.

In the air-to-surface field, the Navy has Petrel and Bullpup. The Petrel is 24 feet long, with a wing span of 13 feet, and weighs 3,800 pounds. It is powered by a turbojet engine and uses radar homing for guidance. Although presently operational within the fleet, it has been phased out of production. The missile was developed under technical direction of the Navy Bureau of Ordnance by the National Bureau of Standards and produced by the Guided Missiles Division, Fairchild Engine and Airplane Corporation.

*"We must maintain the capability to carry out certain basic military tasks. There is no question of relative priority—we have to do them all, and do them all adequately."*

Bullpup is an air-to-surface tactical guided missile designed for use by carrier-based Navy aircraft and shore-based Marine aircraft. It is 11 feet long, weighs 540 pounds, is powered by a solid-propellant rocket, and is being built by the Martin Company's Orlando (Fla.) division. Bullpup is relatively inexpensive, highly accurate, and simple in design. The missile is for use against comparatively small targets—pillboxes, tanks, truck convoys, bridges, railroad tracks, and marshaling yards.

The large submarine-building program of the Soviets makes antisubmarine warfare of prime importance to our Navy. For this reason nearly every ship of the new Navy will contribute, directly or indirectly, to our antisubmarine power. In this field our integrated teams of surface, submarine, and air units are being equipped with modern and effective weapon systems, and we expect continued improvements.

Our submarines are exceptionally well equipped for antisubmarine work, which is now their primary task. Our nuclear submarines increase our antisubmarine warfare capability by being able to go deep, stay deep, and attack quickly.

Our aircraft have always been essential parts of our antisubmarine warfare team. Airborne detection equipment and new weapons, including the atomic depth charge, will add immeasurably to their effectiveness.

WE are now pursuing with all possible speed and at highest priority the development of an intermediate-range ballistic missile whose configuration meets our unique requirements. The official designation of this missile is Polaris. As one of the earlier steps, in December 1956 we commissioned the U.S.S. COMPASS ISLAND, which can be considered the forerunner of a fleet of nuclear-powered, ballistic-missile-launching vessels, both submarine and surface types. Specifically, the mission of this ship is to test the equipment we have developed for precise midocean navigation.

I realize that there may be questions resulting from Mr. Wilson's "rôles and missions" memorandum of last November with respect to guided missiles.

This memorandum applied primarily to the rôles of the Army and Air Force. For the Navy it simply restated the policy that development and operational employment of ship-based intermediate-range ballistic missiles would be the sole responsibility of the Navy.

THE Navy considers that this intermediate-range ballistic missile, the Polaris, will make a perfect marriage with the nuclear-powered missile submarine. Armed with the Polaris missile, the nuclear-powered submarine will become a powerful long-range underwater weapon. It will be large enough to store, maintain, and fire intermediate-range ballistic missiles and it will be able to move anywhere in any ocean at any time, completely submerged, firing its missiles while below the surface of the sea.

Submarines so equipped can be dispersed over literally millions of square miles of ocean ringing an enemy's homeland. The problem of locating and destroying such an underseas fleet would be tremendous. Search radar would be helpless against it.

In concluding, I would like to point out that each service has an indispensable, specialized part to play in the future—in peace or war. No single service can perform successfully without the help of the others. The military power of this Nation rests in the balanced effort of all its services, Army, Air Force, Navy, and Marines—each contributing its best in its own field, each supporting the others in theirs.

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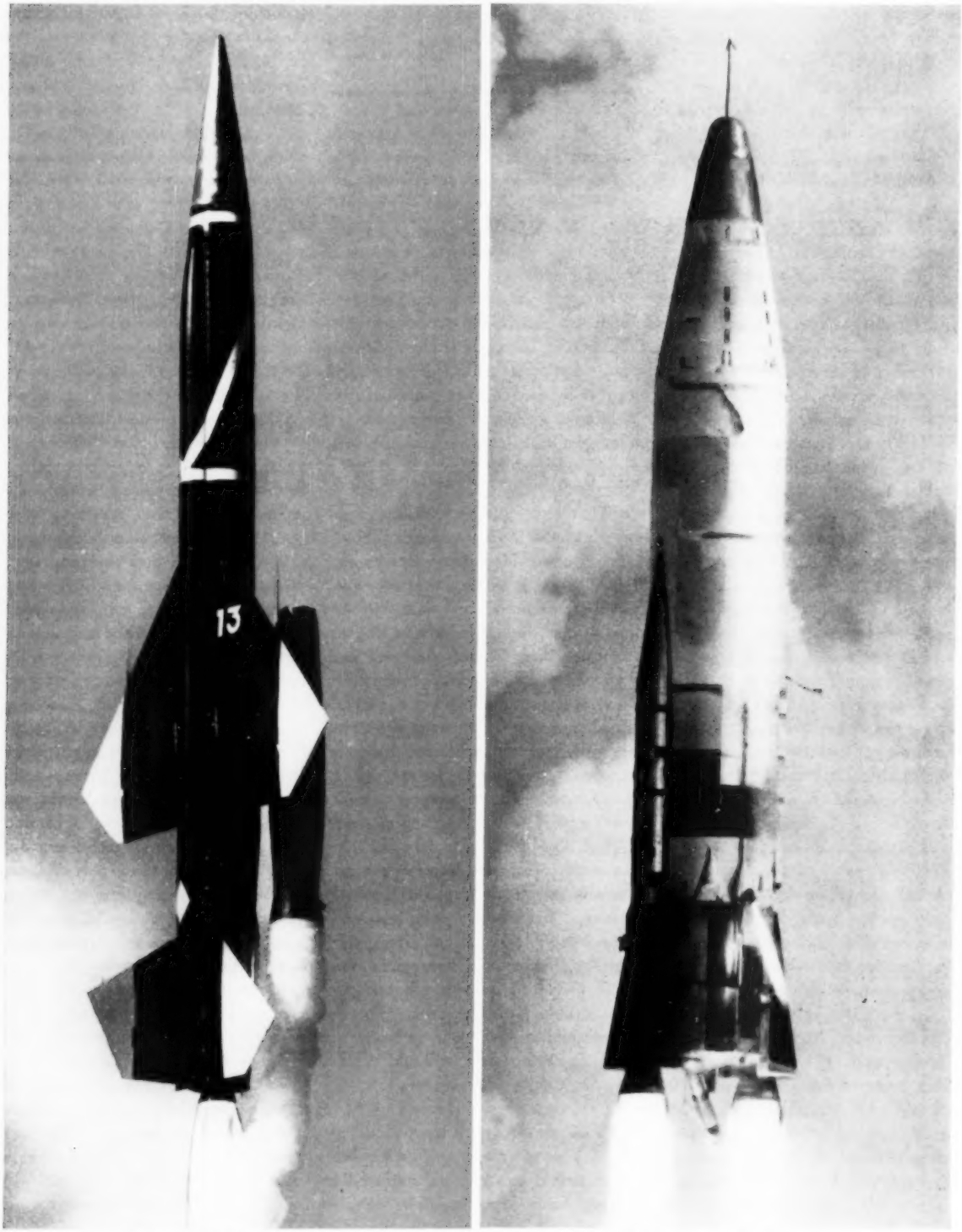
EDITOR'S NOTE.—These remarks were presented at the annual meeting of the A.O.A. Council, New York City, December 3, 1957.

# In the Missile Arsenal




The Bomarc surface-to-air interceptor, left, is shown taking off from the Air Force Missile Test Center, Fla. It has a liquid-fuel rocket booster and two ramjet engines, giving it a speed of Mach 2.5. The Atlas intercontinental ballistic missile, right, uses liquid fuel and has a range of over 5,000 miles with command and inertial guidance (Air Force photos).

# Mobility Is a Must

*Our Army must have both aircraft and ground transport to travel swiftly*

Maj. Gen. John P. Daley

"STRATEGY," says Webster, "is the science and art of employing the armed strength of a belligerent to secure the objects of a war." It is extremely doubtful if any nation can gain the objects of a conflict by a total war which amounts to a near-total catastrophe. We in the Army believe that in limited war hard-hitting, mobile ground forces can make a material contribution to winning the objective of the war. In other words, we feel that mobile, hard-hitting Army forces are truly strategic forces.

We are conscious of the revolution in warfare that has occurred due to the mating of the nuclear warhead with the guided missile. It affects our thinking in tactics, in organization, and in equipment. On the one hand the nuclear warhead and the guided missile give us vast increases in our hitting power. On the other hand, they put a premium on our mobility and on our ability to communicate over extended distances. Matérielwise, then, we have three requirements—improved mobility, better communications, and flexible firepower.

IMPROVED mobility is a must. We must be able to move rapidly over all types of terrain and not be restricted to road nets or by obstacles. Obviously, if we are to have the mobility we require for future wars, we cannot confine ourselves to surface transportation regardless of how efficient our ground vehicles are. Air vehicles capable of operating in the battle environment of the combat soldier are playing an increasing part in achieving the mobility the Army requires.

*General Daley is Director of Special Weapons, Office, Chief of Research and Development, United States Army, Washington, D. C.*

Because of the new dimensions of time and space resulting from widely dispersed units operating over large areas, we know that we must improve our ability to communicate. Communications equipment in the future field Army must be rapid and reliable to give the commander constant control over extremely mobile units. It must operate efficiently over long distances despite enemy jamming and be relatively easy to maintain.

Firepower requirements are quite clear. We need mobile weapons that can be transported easily and quickly by surface or air transport and be employed against close and distant targets with speed, certainty, and precision. We need range to meet the width and depth of the battlefield. We need quickly responsive weapons capable of delivering a punch appropriate to the target.

There is one footnote I want to add to what I have said about matériel. The more complicated the weapon becomes, the more important is the person who employs it, who services it, and who keeps it in operation.

The soldier of the future must be well trained. We must provide him the ability to fight, to survive, and to win on the battlefield of the future.

Mobility in the Army has three major aspects: (1) air transportability, (2) ground mobility, and (3) air mobility. To achieve true mobility we know that everything must move by wheels, tracks, or by air. Many vehicles must be capable of swimming inland waters. Many, in addition to possessing improved ground mobility, must be air transportable. An example of our efforts along this line is the M56 air-transportable 90-mm. self propelled gun —named Scorpion.

OUR most ambitious effort in air defense is the defense against ballistic missiles. We are developing the Nike-Zeus system to defend the continental United States against all air threats including ballistic missiles.

We have had excellent results in the development of an antimissile missile. Components of such a missile already have been constructed and tested. I am completely confident that a defense against the ICBM can be developed.

As we look to the future we are deeply impressed with the challenge the Army faces today. We know that we must have the imagination to realize and fully understand the tasks that face us in providing our Nation with the weapons systems and equipment it requires. It is through these weapons, employed by a modern and mobile Army, that the Nation will find the flexible instruments of military power to serve the needs of our country.

Our objective is to provide the United States with a hard-hitting, fast-moving Missile Age Army capable of applying the right amount of power at the right time and at the right place.

# Tactical Air Power

*The philosophy of our tactical weapons system has been to employ the proper means to achieve the maximum results with the least number of sorties and with a minimum loss of personnel and time*

Gen. O. P. Weyland, U.S.A.F.

FOR the past several years I have been deeply concerned with the part that tactical aviation plays in limited warfare. After having fought in one and been an on-the-scene observer at two more, I am no stranger to such war.

This close association with limited war impressed me with the skill of the Communists in exploiting political and psychological factors to their advantage —either independently or in conjunction with their military efforts.

As commander of the United Nations' air effort in Korea I had the unpleasant experience of abiding with political restraints on one hand and attempting, at the same time, to pursue a military air campaign to an effective and honorable victory. I was restrained from attacking the Communist air bases and logistical establishments in Manchuria. The Reds were close to defeat upon initiation of armistice talks, yet they drew those talks out interminably when the UN naïvely let up on ground-force pressure to save lives, and they ultimately contrived through propaganda to create the impression that they had almost defeated the UN.

IN short, we were poorly prepared militarily, politically, and psychologically for such a conflict.

In Indochina, and this time in the capacity of a firsthand observer, I was spectator to the rather futile and ineffective efforts to stem the Red's acquistion of French colonial territory. The outcome of this conflict was influenced much more by racial, psychological, and political implications than by military effort.

*General Weyland is Commander, Tactical Air Command, Langley Air Force Base, Va.*

It is imperative that we, as a nation, are never again placed in the untenable position we occupied in Korea.

In retrospect it may be found that this situation developed largely because

our reduced military force structure after World War II was necessarily aimed toward deterring the Communists from engaging in general, all-out war.

Therefore our defense efforts and monies were directly largely into the creation of such a deterrent force. This was rightly so, and our strategic forces with their nuclear capability were signally successful in providing such a deterrence.

However, thus deterred from general war, but still pursuing their historic mission of violence and deceit, the Communists continued their offensive in less conspicuous areas. It has long been obvious that the Communists prefer to exert their expansionistic efforts through political, economic, and psychological methods, using the threat of force, when necessary, as blackmail against smaller countries.

If these methods fail, or do not meet the Communists' time schedule, they are willing to use force, providing that force does not overtly involve the U.S.S.R. They are, however, perfectly willing to take the risk of having bombs fall on satellite countries.

FOLLOWING this policy they struck in Korea; rebuffed there, they redoubled their offensive in Indochina.

In pursuing their objective of world domination the Soviet leaders have historically considered the risks involved in each step in relation to the potential advantage to be gained.

From this we may conclude that whenever they had prior knowledge of our will and ability to impose a penalty that would be disproportionate to their gain, they have been constrained from provoking our response. Because no such penalizing capability existed, they chose overt military action in Korea and Indochina and achieved in the latter case what amounted to a major victory.

They gained great stature in the eyes of a large portion of the world's peoples who feel that it was the United Nations that sued for peace in Korea and that France was soundly defeated in Indochina.

On the other side of the ledger, how-

ever, the Communists did not achieve their original objective in Korea. Their timetable for world conquest was disrupted. However, they did learn some lessons from Korea. Chief among these is the fact that they cannot start a successful limited war in an area where the United States already has deployed tactical air forces, as well as ground and naval forces, ready to intervene. Therefore, we can expect them to profit by this lesson and concentrate on the more remote areas of the world for future operations.

It is logical to assume that the Communists' taste of success in Korea, Indochina, and Malaya will now affect a much broader area.

With the northern portion of Indochina well consolidated within the satellite bloc, Thailand, Burma, Pakistan, Indonesia, the Philippines, and even Australia immediately become areas of concern.

Incidently, at the request of the governments of some of these countries I have just paid a return visit to the Far East to examine at first hand the potentially explosive situation that now exists.

Even more significant and still further removed from the key points of air power is the oil-rich morsel of the Middle East, where every day we see further evidence of the Communists' intentions. I cite the Syrian situation as an example of these intentions.

Of major importance to us as a nation, however, is the fact that these previous aggressions, coupled with constant pressure probes on the part of the Reds, gave us clear and unmistakable proof and warning of the sinister nature of the Communists, long-range intentions. We learned our lesson well!

IN categorizing the possible structure and strategy of a future limited war, grave consideration must be given to experience gained in past dealings with this type of conflict.

While the next incident will most certainly not be exactly like Korea, Indochina, or the Suez, we may expect some common characteristics of the set pattern to emerge. For example, regardless of whether we of the military like it or not, political, rather than military objectives may exercise great influence on the determination of those areas which the antagonists will seek to establish as a "sanctuary." This was true in the Korean situation and it may be equally true in the future. By the same token, restrictions on the employment of yields of weapons may possibly be invoked.

It may well be that the area that offers the greatest geographical opportunity for the successful results of military operations could be one that is denied the strategists by political considerations.

I think the sanctuary idea is one that we will be forced to live with in any future limited-war situation. To meet this sanctuary principle and still achieve what I term victory in limited war, our operational evaluation of warfare must be realigned to a new way of military thinking.

Primarily, we must evaluate what elements of the enemy's strength he is willing to risk and where we can hurt him the most with the least risk on the part of our own forces.

For example, it is generally accepted that the Chinese Communists were brought into the war in Korea by the Soviet Union with the promise of matériel support. The most prized portion of this aid, because of the prestige attendant on its modernity and size, was the rapid expansion of the Chinese Communist Air Force. Of all his elements of strength, this was the one that the enemy was least willing to put at risk.

On several occasions in Korea the enemy apparently feared that we would strike across the Yalu at his airfield complex. He then put his air weapons system aloft as soon as possible—not to engage our forces but for the sole purpose of redeploying to rear areas where he felt his forces could survive an air attack.

We must learn to evaluate realistically these inherent operational weaknesses as they appear in the Red strategy and exploit them to our advantage.

There are other primary concepts that need to be realigned and successfully developed. For example, we are aware of an almost infinite variety of possible local war contingencies involving a number of areas in the free world.

We know we cannot deploy our forces in advance to every possible area of conflict. This circumstance initially establishes the requirement for United States forces, under centralized control, which can be deployed very quickly and in time to be effective in assisting the friendly countries and the peoples threatened.

OF utmost consideration, in my opinion, is the extreme importance of time. It appears to me that reaction time may well play as decisive a rôle in limited war as in total war. The Communists might conceivably attack an unprepared area with such strength and with such speed that their objectives could be gained prior to any attempts to block them. Such a situation would be most unsatisfactory for the free world and must not be allowed to occur.

In giving consideration to the force posture to meet these requirements and deter, or, if necessary, fight a limited war, extreme care has to be taken not to weaken our presently proven general-war deterrent force.

In line with this thought there recently has been a great deal of discussion relative to the possibility of a limited war either being a decoy for an impending major war effort on the part of the Soviet or else expanding to a full-scale general war through inadvertence. I believe that either of these two cases is valid only under very particular conditions, such as when we weaken or "bleed off" our deterrent capability through the limited-war medium itself.

We must not be drawn into this trap! If this precept is followed and our deterrent force remains poised for action, the Reds then sacrifice their most priceless asset if they initiate general war under such conditions.

I say this because our national policy dictates that the U.S.S.R. will have the advantage of initiative in striking the first blow in a total war. This valuable asset of initiative and, consequently, surprise, is not likely to be jeopardized

or thrown away through the medium of limited war.

There is no doubt that many problems have in the past, and will continue in the future, to confront us in the area of limited war. For example, in contradistinction to our general-war posture, where we know our primary potential enemy, we cannot forecast accurately in advance where the limited war may take place—or even who the enemy will be. Therefore, planning has been most complicated and difficult.

However, within the United States Air Force we do have, at the present time, forces in being—equipped, trained, and ready to meet the peculiar requirements of limited war, wherever and whenever it comes.

Should the necessity be thrust upon us, the Strategic Air Command is prepared to participate in local-war situations from general-war positions to an extent not appreciably affecting SAC's general-war posture.

Within the Tactical Air Command in the United States we have combat units especially designed to perform the variety of air tasks to be expected in a limited war. These units are backed up with air refueling tankers and transports to provide the required special mobility and support demanded by limited war.

TACTICAL air forces trained in these same techniques and deployed overseas can participate in limited wars if the theater commander's area is affected. However, the movements of theater forces away from their primary area of concern could affect the general-war deterrent posture they present; therefore such movements should not take place if they can be avoided.

Tactical forces in the U. S., on the other hand, are available for immediate deployment to limited-war areas without seriously affecting the general-war posture in either the NATO or SEATO areas. Nor does their use unfavorably detract from our general-war deterrent posture.

Earlier I mentioned a new concept of employing our forces in a limited-war strategy. Such a concept has been developed within my command during the past two years.

The force which embodies this concept is unique in a number of ways. It is known as a "Composite Air Strike Force" and may be tailored in composition, size, and capability to meet the specific needs generated by a limited war.

It is indeed a flexible total weapons system and may employ under varying conditions the complete weaponry spectrum from propaganda leaflets to atomic weapons.

Let me explain the mechanics of this Composite Air Strike Force and evaluate its capabilities in the light of my previous discussion.

First, its command element, established for the purpose of deploying and controlling this force, is the Nineteenth Air Force. It is a small, streamlined, and highly mobile headquarters with integral communications and control elements. In addition to the strictly air end of their ability, they possess the experience and know-how of working with surface forces in combat situations.

Nineteenth Air Force headquarters conducts, on a continuing basis, timely studies of all areas of the world in which possible limited conflict might be forced upon members of the free-world alliance. They examine the availability of airfields, POL and other logistics and support from indigenous forces in the different areas. Based on the facts developed, contingency plans are prepared for possible areas of conflict.

Secondly, in terms of combat units for use in the force composition, there are Century Series supersonic fighters and fighter-bombers—the workhorses of limited war. Also available are tactical bombers and reconnaissance-type aircraft.

These units maintain an alert status consistent with our current deployment needs which require the packaged force to be in place and ready for action in any area of the world no later than four days from time of notification.

Our tanker units make it possible for these tactical aircraft to reach distant areas without landing or with minimum stops enroute. Troop-carrier aircraft are utilized to move our 30-day operational supply kits and essential support personnel. For after we arrive in an operational area we must be capable of sustained 30-day operations.

IN order for us to move these forces quickly they must necessarily remain relatively small. However, the tremendous increase in weaponry makes them highly capable of performing the task at hand.

Weapons available to us cover a wide range of yields available through fission and fusion processes. However their planned use would not be as weapons of mass destruction but for the selective and efficient elimination of purely military targets. The inherent accuracy of our tactical weapons system lends itself admirably to this concept of utilization.

Our philosophy has been one of employing our weaponry so as to achieve maximum results with a minimum number of sorties dispatched and at

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*"The Soviet leaders have historically considered the risks involved in each step in relation to the potential advantage to be gained . . . Whenever they had prior knowledge of our will and ability to impose a penalty that would be disproportionate to their gain, they have been constrained from provoking our response.*

*"Because no such penalizing capability existed, they chose overt military action in Korea and Indochina and achieved in the latter case what amounted to a major victory.*

*"They gained great stature in the eyes of a large portion of the world's peoples who feel it was the United Nations that sued for peace in Korea and that France was soundly defeated in Indochina. . .*

*"The Communists did learn some lessons from Korea. Chief among these is the fact that they cannot start a successful limited war in an area where the United States already has deployed tactical air forces, as well as ground and naval forces, ready to intervene."*

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the same time to achieve decisive results with less loss of life and time than is inherent in the large-scale employment of conventional weapons such as was done in Korea.

IN order to preserve the flexibility and mobility of the Nineteenth Air Force, the combat portions of the Composite Air Strike Force—the actual tactical units themselves—are normally assigned to and administered by the Ninth and Eighteenth Air Forces. The complete packaged force is only assembled in one of two conditions—either to exercise or to fight.

To date we have faced only the exercise portion of our task. We remain ready, when needed, to fulfill the remainder of our job!

The successful and expeditious movement of any size force to the more remote areas of the globe presents quite a challenge to our ingenuity. After our concepts of movement were outlined, they had to be proved. At the same time, our units needed to gain experience in austere field operations.

These requirements have been met through the medium of exercises, not only simulated mission profiles and operations here in the United States but actual deployment and simulated operations in other areas of the globe.

Even now a sizable Composite Air Strike Force is returning from exercises held in various areas of the Far East where it was deployed under our limited-war participation criteria. That force was comprised of the Nineteenth Air Force command element, a squadron of day fighters, a squadron of fighter bombers, some tactical bombers, and reconnaissance—all backed up by aërial tankers and troop-carrier aircraft.

IT is interesting to note that the tactical bombers deployed nonstop from U. S. bases to Clark Field in the Philippines, a distance of some 8,000 miles, in a total elapsed time from departure to landing of 17 hours.

I should like to emphasize here that these were not stripped-down, specially modified versions of our basic aircraft. They were fully equipped, regular combat aircraft—and they were ready to fight when they got there!

*"Firepower requirements are quite clear. We need mobile weapons that can be transported easily and quickly by surface or air transport and be employed against close and distant targets with speed, certainty, and precision."*

Last spring some of our F-100 aircraft departed bases in Texas, flew over designated exercise areas in the Republic of Panama, simulated atomic deliveries in support of ground forces, and returned. The round trip was made nonstop without any intermediate landing.

Similarly, Composite Air Strike Forces have been deployed to Europe and South America to participate in operational exercises in those specific areas.

We have developed a proven capability to get combat-ready forces to most areas of the world, and to get there fast!

This, then, is how we in the Tactical Air Command can contribute to meeting the Communist limited-war strategy with a suitable counterstrategy.

We believe timeliness and quick reaction are of the utmost importance. Generally speaking, the average small, friendly country which is a possible target for local aggression has a capability for effective ground fighting, but few have an appreciable tactical air capability. If they know they will be supported quickly, they may be depended upon to fight in defense of their own country.

The United States Air Force's Tactical Air Arm can provide this decisive element of power in time to be effective.

This force, capable of quick response to the limited-war threat, must continue to remain modern and ready. As long as it does, it presents an important deterrent to limited war and, at the same time, complements our strategic and air-defense forces in providing our general-war deterrent.

As long as we, as a nation, match the Communists' strategy with a counterstrategy and, if necessary, meet his force with force, we have no need to fear for democracy. It is well to remember, I think, that democracies seldom have to fight when the balance of power is in their favor—for then they are not attacked!

**A flight of F-100 Super Sabres, important weapons of the Tactical Air Command.**

# The Navy in Limited War

*While ready and able to deter or defeat local aggression, our sea forces also have the ships, aircraft, and weapons to deter an all-out conflict or to deal devastating blows should the shooting start*

Vice Adm. W. V. Davis

THE two central strategic facts of the post World War II era are: First, the development of nuclear weapons together with the means for their delivery and, secondly, the loss of the old international power balances and the emergence, in place of multiple balance, of the dual power division we now know—the free-world bloc versus the Communist dictatorships.

I need not belabor the fact that the Communist objective is world domination. They themselves have stated it many times. Their continuous probings toward that end have established the condition of world tension as the normal rather than the abnormal.

In the context of these strategic facts and the assigned mission of the Navy we seek to provide the United States and the free world with the most effective military defense possible within our means. We must deter all-out nuclear war and we must retain the flexibility necessary to react to the minor challenges with something less than thermonuclear attack.

The Navy's primary mission is to gain and maintain general sea supremacy and local sea superiority, including the air above and the water underneath. Specifically, we are to: (1) Exploit the sea to defeat the enemy—a very broad mission which will require the use of many elements; (2) deny the use of sea lanes to the enemy; and (3) ensure the unhampered utilization of the sea lanes by our own and allied shipping.

*Admiral Davis is Deputy Chief of Naval Operations.*

The importance of our rôle in war of denying the sea to the enemy and exploiting the sea to achieve his defeat is obvious. The importance of our rôle in keeping the sea lanes open may not be so well understood.

The free world is a maritime coalition largely dependent on the sea for mutual support and prosperity. This is true in peace, war, and limited war.

The United States is itself a "have-not" nation in many ways. To meet our needs we import great quantities of basic raw materials. For example, ninety-five per cent of our requirements for chrome and tin are imported, and the list of other vital commodities shipped is most impressive.

The normal United States transocean transport requirements are large, and we might expect the logistic burdens of any limited action to be an addition to these.

Last year, over 250 billion ton-miles of cargo were carried. Ships carried 99.13 per cent of the military tonnage and 99.66 per cent of the commercial tonnage, the remainder being carried by airlift. There is an excellent economic reason for this disparity in favor of sealift—ton-mile for ton-mile the costs are about one-fortieth those of airlift.

There can be no substitute for the speedy airlift delivery of critical cargo and personnel, but where massive tonnages are required, no substitute for sealift is yet in sight. We will be dependent upon sealift for the main military overseas movement for the foreseeable future. Nothing in prospect promises significant alteration to this fact. The implication here for limited war is obvious. We must keep the sea lanes open in order to mount our large organized forces and for massive movement.

FOR this purpose sealift is not slow. Remember, if you will, those trying days in the summer of 1950. The strategic plum in Korea was Pusan, the best and southernmost port on the peninsula. The situation literally became a race between United States sea power and the land power of the North Korean Army for this vital port. Through sea power, Marine and Army units based as far away as the United States proved to be closer to Pusan than was the North Korean army on the banks of the Hann 300 miles to the North.

Let us now consider the tools of sea power, beginning with the Attack Carrier Striking Force. This mobile, powerful sea base, together with its screening ships and combat aircraft, is the one versatile element that can op-

erate in support of all the main tasks of the Navy.

The rapid advance in nuclear warfare capabilities of the Attack Carrier Striking Force has thrust it into the rôle of an element in our national nuclear deterrent potential. In many areas of the world our naval striking forces can supplement and augment the nuclear capabilities of the Strategic Air Command. In certain theaters they could place bombs on targets several hours before other forces could execute a strike mission.

It has been the Navy's aim to develop mobile, versatile carrier striking forces employing precision delivery of a full family of weapons. Inevitably, we have developed a strong capability in the use of nuclear weapons, but we are retaining our precise delivery systems. The Navy has, therefore, a dual capability both as a nuclear deterrent force and as an effective force for countering local or limited aggression.

In order that there will be no mistake in my meaning with regard to the "full family of weapons," I mean thermonuclear-sized weapons, small atomic weapons, and TNT weapons; and I mean bombs, rockets, missiles, and guns. All are necessary for defense in the strategic situation in which we find ourselves. It is futile to argue that certain weapons can never be used or will never be used, as some have argued in the case of atomic weapons in limited war.

As a practical matter we must have them available and ready to use in the same manner and for the same reason that our larger weapons are maintained in a ready status. The enemy must be offered no choice of action that we are not prepared to counter.

REGARDING atomic weapons, the Navy's needs run from the largest sizes compatible with carrier aircraft to the smallest tactical sizes. Above all we are interested in versatility and variety in our delivery techniques. We want to be able, as the situation may require, to penetrate at high altitude or low altitude and in either case to find, identify, and attack with accuracy any target that may be assigned or be of naval interest.

*"As a nation we have no alternative but to maintain the ability to deter major nuclear war. The primary element of this deterrent must be a capability for rapid and certain retaliation which no enemy can persuade himself that he can stop, either by perfecting his defenses or by surprise attack on our means of effective retaliation."*

We are also interested in multiple carriage of atomic weapons on our attack aircraft and delivery by air-to-surface missiles as well as surface-to-surface missiles. Needless to say, we do not have all that we would like to have in this field, and further development is a must.

While nuclear weapons must be considered of first importance, nevertheless mutual forbearance in using them is a viable method of limiting war and, in fact, one that has existed in every armed conflict since World War II. We cannot discount the importance of TNT weapons.

Carrier air warfare in the past has developed the art of attack with TNT weapons to a high degree of effectiveness. We are retaining this capability.

The important characteristics of a nonnuclear air attack campaign are: (1) High sortie rate, (2) proper weapon selection, (3) properly estimating force requirements necessary for each target, and (4) accuracy in delivery.

The first three characteristics mentioned are operational problems, and it is up to us to maintain a high state of efficiency in each. The latter characteristic, accuracy, is a somewhat different story. It is one of the most important features of the TNT air weapon system and one in which we never have been truly satisfied. We are trying to help ourselves in this respect and are now testing the Bullpup—a nonnuclear air-to-surface guided missile.

The Bullpup was conceived as a result of Korean war experience. Its characteristics allow it to be launched with considerable maneuvering freedom from a position outside the effective radius of enemy high-volume ground fire. It provides sufficient accuracy to destroy small targets without excessive sorties and without expenditure of large quantities of bombs and rockets on each target. Bullpup is expected to provide light attack aircraft with a significantly greater attack capability against pillboxes, tanks, bridges, and similar targets. This increased effectiveness is due primarily to the greatly increased accuracy with which the warhead can be delivered on the target.

We are convinced the Bullpup is a step in the right direction. However, this is an area in which the Navy can still use lots of help—highly accurate, effective, all-weather, air-to-surface weapons.

I MIGHT also mention that the Navy has overhauled its conventional bombs and rockets since World War II and has developed a new family of streamlined bombs and new improved rockets such as the folding-fin Zuni, but these weapons are not going to be in the fleet in the quantity we would like to see them or as soon as we would have had them if we had an unlimited budget.

This practically universal complaint, "limited budget," brings me to another problem area in which the Navy needs help. I can't say we are being priced out of business because we can't go out of business; but we are being priced into difficulties. Level budgets do not mean level forces in an era of rising costs. We need accurate, reliable, efficient modern weapons; but we cannot afford, and the country cannot afford, to pay for any unnecessary frills or manufacturing inefficiencies. It is up to everyone concerned—scientists, designers, engineers, and production men—to take this problem to heart. We must hold costs to the minimum.

It will do us little good to have the finest weapons if we cannot have enough of them to do the job. We can wind up with the second-best poker hand this way as well as through having second-best weapons.

Before discussing antisubmarine warfare I want to cover briefly our con-

cepts in attack aircraft—the aircraft that will be using the majority of weapons I have mentioned.

The attack problem has become more difficult of solution, and no longer will one attack type suffice for all situations. On our carriers we have two attack aircraft types. Heavy attack aircraft can carry large weapons and penetrate to distant targets. They carry the Navy's primary nuclear punch today. They also will deliver nonnuclear weapons and can be used for this purpose if necessary.

The second type is the light attack aircraft. Such aircraft are relatively small so that large numbers can be spotted on our carriers. They are shorter-ranged than the heavy attack aircraft but in most other respects are more versatile. The light attack aircraft are equipped to carry all our air-to-surface weapons except the larger nuclear weapons. The burden of close air support, interdiction, and other limited-war missions will be carried largely by these aircraft.

Let me add here that there is no substitute in sight for the versatility of the small piloted aircraft because there is no substitute for the trained man on the spot using his eyes and his judgment to select the proper target and hit with precision. To date no one has conceived of a missile which can think or improvise like a man. For many years to come the guided missile will be in a complementary rather than a supplanting rôle.

IT also must be remembered that the large surface-to-surface missiles are nuclear-war weapons, and the Navy has no intention of being mousetrapped into relying entirely on any weapons systems that restrict it to being able to fight only one kind of war. Missiles do some things far better and under some circumstances are the only means, but they are limited in versatility, and to eliminate the human being with his ability to exercise judgment on the spot would be to build in a rigidity that would leave us vulnerable in many areas.

One of our most serious problems is antisubmarine warfare. The current estimate of the Soviet submarine strength is in the vicinity of 500. Their ultimate goal may be as many as 1,200 submarines. The magnitude of the threat can readily be seen when we realize that Hitler had about fifty-seven submarines at the start of World War II.

I want to treat this subject in its broadest aspects. Too often the discussion of this problem is confined to a review of the capabilities of specific items of hardware, such as sonar and sonobuoys. This tends to confine a subject such as this to narrow limits which hardly do it justice.

In any kind of war the most productive method of eliminating submarines will be to go after them at their bases and destroy their support facilities.

Our Attack Carrier Striking Forces are really the vanguard of our antisubmarine forces. At the outbreak of war, these forces are assigned and scheduled to attack targets of naval interest. Primary targets of naval interest are submarine bases and support facilities. These bases are vital to the Soviets should they ever mount any kind of sustained submarine offensive. Even nuclear-powered submarines require base support for ordnance and stores, to say nothing of routine maintenance.

In this respect, submarines are much like airplanes in that they require a great deal of maintenance. The submarine is a complicated piece of machinery, and sustained operations away from base result in a gradual degradation of operational effectiveness. One of the by-products of sustained operations at sea is the fact that submarines get progressively more noisy. This, of course, facilitates the task of detecting them.

Modern nuclear weapons have made the job of disrupting submarine support activities much easier. The objective can be realized in most instances in one or two accurate strikes per target.

In a limited war where the submarine bases might be in sanctuary we would be in a lot more trouble. I do not feel, however, that a situation in which the total strength of the Russian undersea fleet is encountered can be defined as limited. Such an all-out effort on their part would call for an all-out response, and they know it.

For the sake of discussion one might conceive of a situation in which a limited number of submarines were encountered in a limited war. We still have a bagful of tricks.

LET'S look for a moment at what might well turn out to be the Achilles' heel of Soviet naval ambitions —their geography. For a country that aspires to naval power, they suffer from certain built-in handicaps of physical geography. Their navy at present is broken up into four major units or fleets—the Northern, Baltic, Black Sea, and Pacific. A glance at the map will show that egress from any of these major areas entails transit through predictable and well-defined routes.

In the case of the Baltic and Black Sea, these are narrow straits. In the North Sea the fleet must pass between the North Cape and the icepack and again between Greenland and the United Kingdom. In the Pacific the only exit to the open ocean is through the Sea of Japan and the sea of Okhotsk. Exit from either of these seas requires passing through island chains. Only from the Kamchatka Peninsula could the Soviets exit directly to the Pacific Ocean.

This limiting geography provides the second area in which we plan to fight the submarines. In these exits to the open ocean we could establish barriers

*"The normal United States transocean transport requirements are large, and we might expect the logistic burdens of any limited action to be in addition to these.*

*"Last year over 250 billion ton-miles of cargo were carried. Ships carried 99.13 per cent of the military tonnage and 99.66 per cent of the commercial tonnage, the remainder being carried by airlift. There is an excellent economic reason for this disparity in favor of sealift—ton-mile for ton-mile the costs are about one-fortieth those of airlift."*

to take a toll of submarines attempting passage. Barriers should and must be backed by hunter-killer forces which operate wherever intelligence indicates that there may be a submarine concentration.

Even with the depth of defense represented by these measures there will be a few submarines which will get through. So we must provide close-in protection to our shipping. This will require grouping ships and providing them with destroyer and aircraft escorts.

Fighting the submarine in the open sea is a difficult job and requires very specialized forces. Our capabilities have increased markedly since World War II, but we still have a lot to learn and a long way to go before we can truthfully say we are on top of this situation. Our best advances in antisubmarine warfare have been in the ability to localize and destroy the submarine once it has been detected. This points up another area in which the Navy needs help. We need improved means of searching large ocean areas for submerged submarines.

ANY limited situation involving a submarine threat will probably result in attrition to both sides. Our objective will be to create an attrition balance so unfavorable to the enemy as to make further submarine employment unprofitable. I might also add that efficient antisubmarine forces in being may be the ounce of prevention needed to restrict ill-considered employment of submarines by a potential trouble maker.

As a nation we have no alternative but to maintain the ability to deter major nuclear war. The primary element of this deterrent must be a capability for rapid and certain retaliation which no enemy can persuade himself that he can stop, either by perfecting his defenses or by surprise attack on our means of effective retaliation. An undefeatable capacity to counterattack with sufficient forces is our best hope for deterring nuclear war. But a force for this task does not give us the required multiple capability.

We also must provide the means of deterring or defeating local aggression. To this end we must provide weapons, and techniques of delivering them, which will not result in the expansion of the limited action into something larger and more serious. It goes without saying that our means of meeting these two very different requirements of deterring nuclear war or combating local aggression must be as economical as possible, consistent with effectiveness.

For deterring all-out war, the United States must process striking forces which are powerful, varied in operating techniques, and as invulnerable to surprise attack as we can make them. Our forces must be varied in operations, because if we rely on only one type we make it possible for the enemy to exploit our weaknesses or, at least, he may more easily convince himself he has solved his defense problems and in this belief launch the surprise attack.

A VARIETY of forces also lessens the vulnerability of our national striking power to any single type of enemy attack. A mobile base for aircraft and missiles, for example, will be relatively invulnerable to the very-long-range missiles of the 1960-1970 decade. Thus the importance of maintaining retaliatory capability at sea is obvious.

In opposing limited aggression, the United States has required and always will require armed forces possessing very versatile characteristics. Here the emphasis must be placed on the ability to get to the scene quickly and to apply appropriate force, which may be either conventional or atomic weapons, with precision to military targets. Let me emphasize three words here—*appropriate* force, *precision* delivery, and *military* targets. We must not plan to use megaton bombs when TNT or small atomic weapons can do the job.

If we can deliver weapons with precision, we can use the less powerful weapons effectively. If we stick to military targets, using against them small weapons delivered with precision, we minimize those factors which tend to enlarge and prolong a war. If we are to maintain readiness for both the nuclear deterrent and for stopping local aggression, certainly it is desirable to put a good share of our effort into forces which can do either type of job.

WE in the Navy are building for the future with these thoughts in mind. We are not so naïve as to believe that we can singlehandedly win a war. We do believe that no war, no matter what its size or scope, can be won without the power and mobility of a modern, strong, and effective navy.

*"The recent demonstrations of our enemy's long-range rockets and nuclear-weapon capabilities highlight the challenge of this nuclear age. Our preparations for attack and defense of the free world in any general, all-out war are of prime importance. We must have a clearly demonstrable and operationally available capability for massive retaliation and a going and effective program for its continued improvement. Anything less than this will lead to disaster.*

*"Our Strategic Air Command and our naval forces with their air-atomic weapon systems represent ready capabilities today, and the national effort to develop our IRBM and ICBM weapon systems will soon develop tomorrow's. These programs are currently receiving maximum national attention. However, once such capabilities are developed, once both sides have achieved long-range air or missile atomic systems, their use implies unacceptable hazard to both sides.*

*"It is time to consider the need for other equally important political and military deterrents to Communist aggression . . . with emphasis on military deterrents . . . since political deterrent has little meaning except from a position of strength."*—IRA G. ROSS, *director, Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y., before the seminar on limited war capabilities during the Thirty-ninth Annual Industrial Preparedness Meeting of the A.O.A. held at the Waldorf-Astoria, New York City, December 4, 1957.*

# The Marines Are Ready

*Always faithful to its tradition of being the first to fight, the Marine Corps is developing new tactics and equipment for warfare in the nuclear age which make it a powerful mobile deterrent force*

Brig. Gen. Richard C. Mangrum, U.S.M.C.

IT has been my observation that in any kind of war there is usually enough fighting for everybody, and the Marines think they have some specific talents for the business.

So whatever kind of war the future may bring—atomic or nonatomic, general or limited, large or small, hot or just warm—of one thing we may be certain—Marines will be in it. They will be in it right away, first, because they will be needed and, secondly, because they will be ready.

Marines have been shot at in all kinds of wars in the past 182 years, and, from the standpoint of a man who is being shot at, the term "limited war" is purely academic.

The last "limited war" we had a hand in was Korea, and I don't doubt but that from the viewpoint of the Republic of Korea and of the United Nations' forces, the term "limited war" has little meaning.

Korea was a limited war, however, because we refrained from destroying, as we could have done, the sources of enemy strength beyond Korean borders. And we exercised the restraint which kept the Korean war limited when we still had a monopoly of atomic bombs.

BUT the world situation has changed since 1950-1953. It has changed because we no longer have a monopoly of atomic bombs. Now that the Sino-Soviet axis has its own capability for mass destruction, we can expect it to take greater calculated risks that limited objectives can be sought without triggering the "broken-backed" war.

*General Mangrum is Assistant Deputy Chief of Staff for Operations, Marine Corps Headquarters, Washington, D. C.*

Under the mutual threat of massive destruction it is more than ever likely that another Korea will develop, or another Vietnam. One may, indeed, be fought with unparalleled violence—including the smaller tactical nuclear weapons. Another may be fought under the threat of such weapons, without their actual employment.

The Marine Corps has believed since 1945 that this time would come, and that the United States must have versatile, highly mobile forces capable of dealing with all gradations of incursion and aggression; in short, that we dare not leave a hiatus in our operational capabilities between pious indignation over outrageous Communist behavior and delivery of thermonuclear weapons.

Everybody seems to agree, now, that a first requirement in modern warfare, limited or otherwise, is the ability to move out fast to counter aggression or bolster the courage of a threatened friendly nation. That's nothing new to the Marine Corps. Generations of Marines have cultivated a tradition of being ready to go in a hurry. Readiness is a function of many things—leadership, training, organization, equipment, planning, etc.—but, most importantly, readiness is a state of mind. This takes time to cultivate. I won't say it is a habit which comes from generations of experience and tradition, but I would have to say that that helps.

Beyond this, the Marine Corps' view of requirements for limited war derives basically from an immutable fact of world geography—three-fourths of the world's surface is water.

THE great power and influence of the Western world stems from its ability to use the seas to reach every spot on the periphery of those seas. Historically, every great excursion from central Eurasia petered out when it reached the sea. Modern sea power will be a major factor to keep the Iron Curtain from falling around our friends who live on the shores of the seas. It may, indeed, be the decisive factor.

Naval forces, with their high degree of mobile logistic self-sufficiency and broad flexibility to apply the right degree of force required by the situation, inevitably must be the primary source of sustained meaningful help against Communist aggression or incursion.

The Marine Corps' historic rôle and present function as a part of those naval forces is to bridge the gap between ship and shore against hostile forces.

Providing landing forces to accomplish this naval task is the mission assigned to the Marine Corps by the National Security Act. Rather than take time to review these provisions of law, I believe it will be useful to refer to a statement made this year when the Marine Corps came up for renewal of its annual contract before the House Appropriations Committee. The report of that Committee contains this declaration:

"The necessity for a strong Marine Corps in our national defense establishment cannot be overemphasized. The striking power of the operating forces of the Marine Corps consists primarily of three combat divisions and three air wings with supporting forces. These forces, now deployed in this country, aboard ship and in advance bases in the Pacific and Far East, form a striking force immediately available and prepared to fight in a general war, a small war, or a limited war. Recent events have again proved the importance of having Marines deployed in overseas areas. Such deployment makes them instantly available for any emergency in the potential trouble spots of the world.

"THE funds recommended by the committee are based on a continuation of this deployment and *will enable the Marine Corps to fulfill its traditional rôle in the national-defense posture of this country as the Nation's force-in-readiness.*"

The Appropriations Committee made some other pertinent remarks, one of which I will mention a little later. But first I would like to discuss the matters touched on in this general statement.

Our three combat divisions, three air wings, and supporting forces are mobile forces, assigned to the fleets, ready to move with the fleets, and in some cases moving in company with the fleets at this moment. Because of the inherent mobility of naval forces, these Marines can be said to possess a true "intercontinental capability" today.

Let's look at a few examples. The 3rd Marine Division and 1st Marine Aircraft Wing are assigned to the 7th Fleet and are based at Okinawa and Japan. The wing was engaged in Korea from 1950 on, as was the 1st Marine Division. But the 3rd Marine Division—which never reached Korea—was moved to forward bases in Japan in 1953 as another form of pressure on the Communists to terminate hostilities. The significance of this fresh, ready landing force must have been apparent to the Communist negotiators at Panmunjom—who could hardly forget the earlier turning point when the landing was made at Inchon.

Hundreds of miles from Korea, this Marine air-ground force still has an important rôle in maintaining quiet along those armistice lines, but it is in no sense "tied down." The United States has other interests and commitments in the Western Pacific, and they require the kind of mobile, flexible capabilities that these Marine forces provide.

For example, we are a member nation in the Southeast Asia Treaty Organization. In presenting the treaty to the President, Mr. Dulles noted his belief—expressed to the other member nations—that the United States would serve best "not by earmarking forces for particular areas of the Far East but *by developing the deterrent of mobile striking power plus strategically placed reserves.*"

Since the formation of this treaty organization our Marine forces in the Far East have played a highly significant rôle in a succession of exercises and demonstrations—some joint and some combined—in the Manila Pact area. If the United States had to intervene there against Communist aggression, Allied forces would require—and expect—United States air and naval support. Logically, therefore, a part of the Marine task in the area is to help train these national forces to use air and naval support.

As an example of a larger force requirement, in September and October we had in the Mediterranean, as a temporary reënforcement of the Sixth Fleet, a Marine air-ground task force—about a third of a Marine division and Marine aircraft wing. The purpose of dispatching this force was to participate with Greek and Turkish forces in long-scheduled NATO exercises, called "Operation Deepwater." However, like other deployed naval forces, these Marines were ready for anything.

This is an important point. Because of an almost continuous schedule of exercises with the fleet—some small, some large—we seem nearly always to have a combat-ready force already embarked, or being embarked, whenever a sudden crisis prompts a call for the Marines.

WITH this brief review of our current posture in support of the National Security, I would like to turn to another remark from the report of the House Appropriations Committee:

"The Marine Corps is moving forward with its current doctrine of helicopter-transported amphibious assault and subsequent highly mobile operations ashore. The Marines, as in the case with the Army, are faced with the problem of fighting a ground war in a nuclear age. To successfully perform this operation the entire organization, operational concepts, and material programs of the Marine Corps must be thoroughly reviewed and analyzed on almost a day-to-day basis. The Corps is proceeding with such a review including testing of these modern techniques under actual field conditions."

If I may paraphrase, "the *rôle* of the Marine Corps is traditional, but the scene is changing."

We are faced with the problem of fighting in the nuclear era, but, in changing our organization, equipment, and methods, we have to keep our minds on the job to be done, and we have to realize that the job may have to be done at *any time.*

We have been living in the nuclear age for several years now. After World War II our first, immediate adjustments had to be made largely in terms of the ships, weapons, and know-how then available. Like other elements of the fleet, the Fleet Marine Forces had to think increasingly of protective dispersion, with a faster concentration to attack. We had to pay even greater attention to rapid movement across and inland from the beaches. We found

that much could be done with the means available.

We found that when atomic weapons are used they are not just to be feared. For any offensive-minded force they are to be exploited. With these weapons available, the amphibious force can compress days of preliminary bombardment into a few minutes of time. We found that our tracked landing vehicles—the amphibious tractors—offered good protection from atomic effects and provided an interim vehicle for pushing rapidly across country from the beaches.

We have been testing and training, and since 1952 units of the Fleet Marine Forces have participated in a number of "live" atomic exercises in Nevada—attaining psychological readiness to attack quickly through and over atomic impact areas.

WE also have been making steady progress toward the attainment of a radically new capability for sudden, sustained attack from the sea. This new doctrine was developed right after World War II to meet the requirements of atomic warfare.

A major key to this development has been the helicopter to carry the assault forces from ship to shore and also for continuing support of operations ashore.

The use of this versatile aircraft permits us to launch the attack with a far greater element of surprise from moving ships, dispersed and well out at sea.

It makes us much less dependent on beaches, tides, and currents, and it gives us much greater latitude in the selection of tactical formations for the assault.

And this is highly important: The landing forces retain their high tactical mobility *after* they land.

IT certainly is a long step from such a concept to a full capability. We require a great many things, most of them costing money. Since we have to be continuously ready with what we have at any given moment, we can achieve the ultimate capability only by stages.

However, I want to emphasize that we have right now a significant, highly useful part of our planned capability in each of our three air-ground combat-ready teams.

The Marine force which participated in the "Deepwater" exercise with the Sixth Fleet in the Mediterranean included a helicopter air group. I regret to say it was not embarked on a ship designed for the purpose—but we are gratified that the Navy recently contracted for the first in a series of keel-up helicopter transports—another major element in attaining a balanced United States fleet in the modern image.

As we move forward in our various programs, the direct beach assault from the sea will gradually assume a lesser part in amphibious operations. Ultimately beaches will be required only for the introduction of heavy combat vehicles, equipment, and logistic support, and these beaches will be seized from the flanks or rear by helicopter-landed assault forces.

In working toward our objectives we are not merely developing a new way to put an old kind of force ashore.

We are providing more firepower, we are adding flexibility, and we are providing the means for more rapid maneuver.

Rocket artillery like Honest John and Lacrosse is partially replacing more familiar artillery. Terrier and Hawk surface-to-air missiles are replacing obsolete antiaircraft artillery weapons. The Ontos is a new antitank weapon. Lighter rifles, machine guns, and mortars are in the offing.

Two new supersonic all-weather interceptor fighters are in service—the Douglas Skyray and the Chance-Vought Crusader—both carrying either guns or the Sidewinder or Sparrow missile. A new light, extremely fast attack airplane—the Douglas Skyhawk—is in service, capable of carrying either conventional or nuclear weapons as may be required.

New developments in motor transport, as well as in all other equipment for the landing force, are primarily directed toward air transportability.

Marine Corps aviation supports the operations ashore initially either from airplane carriers or prepositioned on airfields within supporting distance and, as soon as possible, from within the beachhead. Here again, new developments will add flexibility and mobility. Portable shore-based arresting gear is already extremely successful. Development of a portable shore-based catapult is a more complex problem but is proceeding with great promise of success.

SOMEDAY the airfield construction problem will be eliminated. Ultimately, we hope to have a family of VTOL or STOL aircraft. The Marine Corps has long since stated a requirement for this type of aircraft.

I believe these few examples will suffice to show we are not looking for gadgets. We are looking for increased mobility, flexibility, and firepower. Development of landing-force tactics and equipment is a primary responsibility of the Marine Corps, and it all has been pointed toward the achievement of a new capability which will meet the requirements of amphibious operations either in general war or in limited war.

In doing these things we are adapting the developments of the other services whenever we can. Where these do not fill our requirements we are pushing forward on weapons, equipment, organization, or tactics which may be unique to our own mission.

In all this development we do not expect to find *any* device, or *any* method that can make obsolete the human element—the Marine himself—the man who, as in all of military history, past or future, must finally and ultimately seize and hold ground by personal combat if our forces are to achieve victory.

THIS is reflected in some recent remarks of the Commandant of the Marine Corps to a group of young officers in Quantico:

"The Marine Corps offers little but tough training, strict discipline, rigorous duty stations, and eternal readiness for battle—and the satisfaction of a good job well done."

# Why Limited War?

*Our armed forces must be equipped and ready with weapons systems that will best serve national policy and not allow our Nation only a choice between catastrophic disaster and unconditional surrender*

Lieut. Gen. James M. Gavin

I AM disturbed by the many years that have elapsed during which we have been preoccupied with the subject of limited war, during which it repeatedly has been brought to our notice as a matter of great urgency, during which there have occurred fifteen limited wars—and yet only recently has the public become concerned about the possibility of limited war and the need for coördinated national action to deal with this problem.

I refer to a time period, and to me that period began with the end of World War II and the advent of fission.

Such a war occurred in Korea, and it is not too soon to put down in black-and-white some of the lessons of that conflict. Among the more important certainly would be these:

1. The rapidity of our response at the outset was critical.

2. The nature of the forces we sent to deal with North Korean aggression was likewise critical.

3. Finally, our force, to be decisive, had to be adequate in strength and superior in means. We were neither strong nor superior.

HAVING failed, therefore, to quench the flame of aggression at the outset, the next decision was determined by the rapidity of our build-up and, again, the superiority of our means. In my opinion, in both of these we were again lacking. And this very shortcoming on our part contributed directly to the prolongation of that "police action," as we now call it, until our casualties reached 142,000 killed, wounded, and missing.

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I believe that all of us in the military services, charged as we are with providing military advice to our people, must share the burden of the outcome of the Korean action. We shared a burden in the fighting, but we also must share the responsibility for either giving poor military advice or for failing to be sufficiently persuasive so that our military forces could have been better equipped to deal with that "police action" when it did occur.

Now we are on the threshold of a new era—the Missile-Satellite Era. But before discussing this I would like to make one final observation on the period immediately following World War II, the period during which the Korean action occurred, and the period from which we are now emerging, for I believe our present thinking is largely influenced by what happened during that time.

For a number of reasons—military to some, economic to others, and some of both to still others—we placed our main reliance upon massive nuclear retaliation in the late 1940's and early 1950's. I believe it fair to say now that we then believed such retaliation would be adequate to serve the needs of national policy. The acceptance of such a view soon found reflection in the dwindling effectiveness of what many like to refer to as "conventional" forces.

A decreased investment of our national product—budgetary support, in everyday terms—was made for other forces not only in direct procurement but also in research and development. They were comparatively lean years for the so-called "conventional" forces. (That seems to be an accepted descriptive term. Actually, as of this date, nuclear forces in every category are now conventional, and this includes tactical nuclear forces.) We are now beginning to see a shift in relative military strength. Sputniks I and II and the remarkable, and in many ways spectacular, missiles now in the Soviet Army make this quite apparent. The real danger, therefore, is that we may have inherited an attitude toward so-called conventional forces that might inhibit those forces in their development at the very time when the need for them is greatest.

No longer may we prepare to defend against a *theory* of war. Now that the threat is real and finite we must, if we are to survive, prepare against

the *threat* of war. We must face the realities of today.

IN discussing limited war and over-all strategy, the analogy of the sword and the shield is frequently used. That is to say, a well-balanced strategy consists of two principal elements, the shield that protects a nation's vitals and war-generating power and the sword that is used to strike.

In order for a nation to survive, both must be effective—just as effective as we can make them.

This country and its vital overseas installations and field forces must be provided with the most effective defenses against air attack obtainable. Thus will we have the greatest possible freedom of action in employing the sword in limited wars, if policy so requires.

Referring to the United States as a separate entity, the question arises, what is an effective air defense? Let us select any one area, any municipal area, industrial complex, or SAC base. Is it possible to obtain a one hundred per cent defense of such an entity?

First we must answer the question, when is a defense one hundred per cent effective? Is it when it destroys entirely any attacker, either manned aircraft or missiles? Not necessarily. Let us turn to an analogy that we know well—defense in land warfare.

In World War II the defense of Malta against amphibious and airborne attack was one hundred per cent effective because it was never so attacked. It was never attacked because Hitler and Mussolini concluded that such an attack would be too costly. So it was with Gibraltar and our own Panama Canal Zone.

Applying this to specific sites in the United States, is it possible to attain such a level of defense? It is, of course, difficult to say since the final answer will only be known when events have passed and the dust is settled and it is found that the site under consideration has not been attacked. However, from the viewpoint of research and development the goal must always be a defense on this level—a defense so impressive as to deter any attacker. And, of course, it would be a very poor research and development program indeed that aspired to a goal of something less than the greatest possible effectiveness.

In concluding these comments on air defense I would like to refer to the public record of hearings before the subcommittee of the Committee on Appropriations of the United States Senate. Although the exchange pertains to the Army Appropriation Bill, I see no reason the point of view expressed would not be appropriate to a program of any service contributing to the air defense of any country. Pages 892-893 of the record of hearings referred to include an exchange between a member of the Committee and myself. I should add that this discussion, or a discussion of this nature, has taken place on quite a few occasions during the past several years.

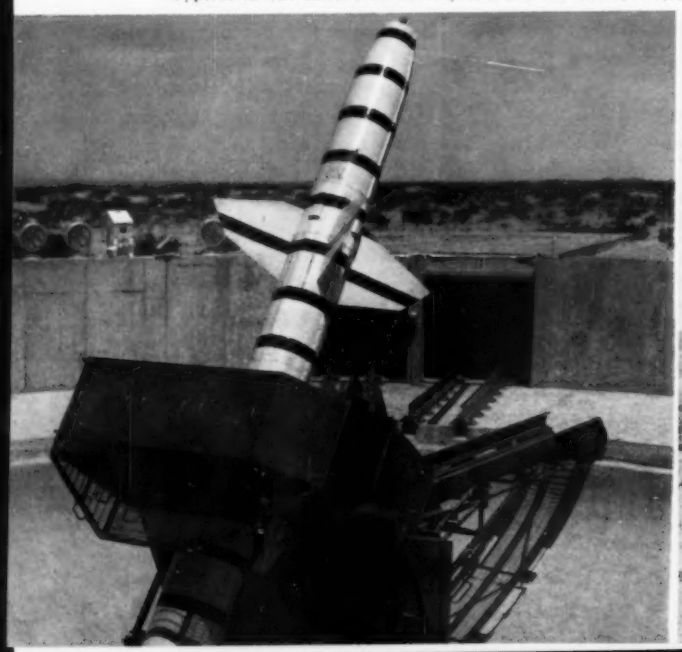
After discussing the defense of a specific area, Washington to be exact, a statement was made as to how many planes it would be possible to assume were to attack. A figure of 1,000 planes was assumed. The point was made that sooner or later enough planes will be launched so that one plane will get through the missile defenses.

The question was asked: "If you take the premise that, in the hydrogen age, some planes are bound to get through, does that not negate the very heavy investment that is involved in Nike?"

My response: "No, sir. We do not think so at all. We do not make the assumption that anything will get through. We are after one hundred per cent effectiveness in defense. And with the nuclear Hercules, the Talos, and the Hawk system, in a mixed complex, very little, if anything, is going to get through."

AT another point in the record, page 879, in response to questions on the effectiveness of air defense, I made the following statement: "Well, we want a one hundred per cent air defense. And we consider this attainable. There has been no schizophrenia in the Army about how to get an air defense. We have not worried about interceptors.

**Typical of our missile defense system are the Talos, left, shown on its automatic launcher, and the Army's Hawk, right.**



We have gone after missiles. And our country, as a consequence, has missiles today, unlike a number of countries in the Western world."

I am quite sure that there will rarely be any defense in applied military power so fully effective that every single element in the attacking force will be destroyed. I have no doubt, however, that in the nuclear-missile era when a nation so elects to defend a specific site it could provide an air defense so effective that it would not be worth the cost to an attacker to make a direct attack upon it. Such a defense would be one hundred per cent effective against the type of attack contemplated, and although difficult of attainment it should be the goal of a sound research and development program.

When the shield of the nation is highly effective then the sword becomes more effective. Then our capability to engage in limited war and general war is significantly improved.

BEFORE leaving the subject of air defense, I would like to comment on two statements that I have made during the past year. In March of 1957, before the Military Industrial Conference in Chicago, Ill., in referring to air defense, I stated:

"One of the most significant aspects of the missile era is that the nation that controls the land areas will control the space above them and, to a large extent, about them. Our greatest deterrent against aggressive attack is in our atomic-missile defenses in the period we are now entering."

As a matter of fact this statement also was made in an open hearing before Congress on our air-defense budget. "Space above" the land referred to usable air space as we then understood it. Since then we have had Sputniks I and II and now we are entering the satellite era. In my opinion, in this era the control of space, and this includes outer space, will be the decisive factor in our survival.

Several weeks ago, speaking in Minneapolis, Minn., in reference to this subject, I stated:

"Now there is but one reaction; we must go ahead with our sister services to provide this country with the vehicles that will give us complete freedom of operations in space. We agree with the recent statement of Dr. Teller—the nation that controls space will control the future of the human race."

Control of space—and this includes outer space—is a prerequisite to the control of land.

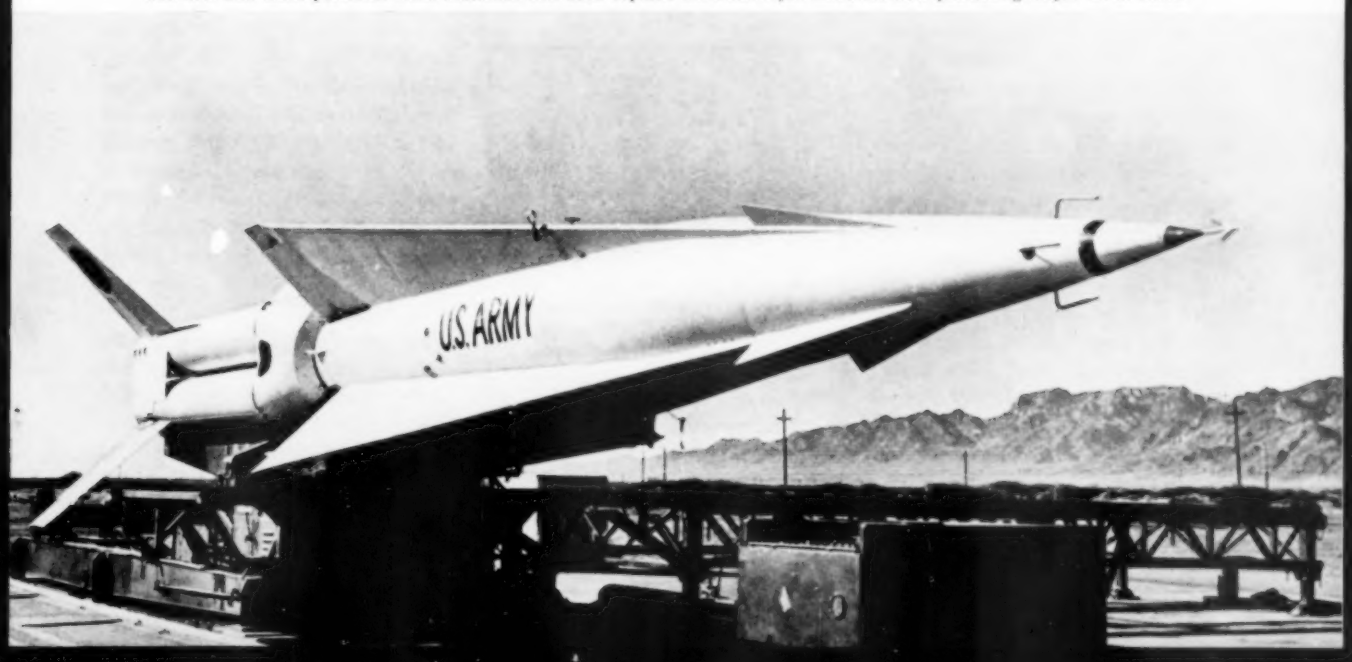
Today the U.S.S.R. has in outer space, encircling the earth, a satellite. In the future, additional satellites will be launched, and soon they will clearly have a military reconnaissance capability. Such a military satellite, matched to an ICBM inventory, will be an impressive weapons system. The possession of such ICBM-satellite weapons systems will bring us to a period of hair-triggered existence, a period in which the future of our people may well hang by a thread, and a slender thread it will be.

Under a canopy of fear created by such weapons systems in the hands of a potential aggressor, nibbling actions may be undertaken by the Communists around the periphery of the U.S.S.R. We must be clearly capable of dealing with such actions. If we are to have a capability of dealing with these nibbling tactics—limited war, as it is now popular to call it—then our research and development programs must reflect our concern now. For only by having the capability of responding rapidly to such aggression, and responding with forces tailored unquestionably to gain the decision promptly in the area of aggression, can we survive.

SINCE time immemorial, military men have turned to science and industry for the most powerful and most destructive weapons they could obtain. They then in turn took these to battle, to the area of decision, and applied them in military action in the furtherance of national policy. The question has always been, *what* can we obtain? Rarely, *why* do I obtain it or *why* do I use it?

Man now can obtain sufficient force to destroy a sizable portion of the human race. Since wars have usually been fought for the purpose of creating a better set of conditions than existed

**The new and more powerful Nike Hercules will soon replace the Nike Ajax batteries now protecting major U. S. cities.**



prior to the initiation of hostilities, it is obvious that the purpose of war will not be served by widespread, catastrophic destruction of friend and foe alike. We must, therefore, first obtain an answer to why force is used at all, and this will lead us to an answer to the primary question: "Why limited war?"

The military forces of a nation or coalition of nations in the free world serve the same purpose as the police force in the city community. Around the periphery, walking the beats, are the city police with adequate power available to deal with local criminal aggressions. To the extent that they can deal with it promptly and effectively, they serve their community effectively.

The policeman on the beat must be backed up by local reserves, precinct reserves, let us say. These reserves must have the capability of moving very rapidly and bringing to bear adequate power, adequate both in terms of discrimination and effectiveness. These, in turn, are backed by the entire resources of the community.

In the community of the Western world we have an identical situation to deal with. Sufficient power must be available, and since this is the nuclear age this is nuclear power to deal swiftly and decisively with any local threat or aggression. Such power is, of course, applied in limited form, limited in that it is used solely against an aggressor and only to achieve a limited objective —deter aggression on the spot.

LOCAL reserves, which in the world community are geographically disposed to back up threatened areas, should likewise have the capability of applying power in a limited war swiftly and severely. To the extent that such reserves deal effectively with a threat, we can avoid general war. To the extent that they fail to deal effectively, we invite general war.

Since general war is clearly catastrophic in its implications, we must have the most modern, exceptionally well trained and capable forces, highly responsive in terms of mobility, that we can create to deal with limited actions.

Why limited war? As a possible alternative to catastrophe to the human race, in order to ensure that we have weapons systems that will serve policy and not allow our nation only a choice between disaster or surrender.

WHAT is the Soviet view of limited war? Perhaps the best source of authority on Soviet military philosophy is the writings of Lenin, Stalin, and some post-1945 Soviet historians on this subject. It is interesting that their military philosophy stems directly from a German military philosopher who served for many years with the Russian Army, Von Clausewitz. He is best remembered for his statement: "War is a mere continuation of policy by other means." Of this, Lenin has written: "The Marxists have always considered this axiom as the theoretical foundation of every war."

To the best of my knowledge, and I have read extensively on this subject, I have never found an exception to this point of view in Soviet military writing; *i.e.*, that war is but a continuation of policy and that, in fact, war and peace are inseparable.

It has been said by Marshal Stalin that the Soviet state is at war and will remain at war with the West until Communism triumphs. Only recently Khrushchev said, "We will bury you," and more recently, at the end of the Moscow meeting celebrating the fortieth anniversary of the October Revolution, a manifesto signed by the U.S.S.R. propounded once again the Soviet desire for peace, on Soviet terms.

Paradoxically, while the Soviets preach of the inevitability of war and a continuing war, they also talk of peace. Hardly was the ink dry on the manifesto of November 18, 1957, than they issued another manifesto, proclaiming their overflowing desire for peace with the West. One is reminded again of Von Clausewitz' statement: "A conqueror is always a lover of peace; he would like to make his entry into our state unopposed."

Then there is Stalin's statement to H. G. Wells in 1934, in which he said: "Communists do not in the least idealize methods of violence. They would be very pleased to drop violent methods if the ruling class agreed to give way to the working class."

Thus the Stockholm Peace Petition was being circulated at the instigation of the U.S.S.R. and Picasso's White Dove of Peace was being exploited while American young men and United Nations young men were dying by the thousands at the hands of the Communists in Korea.

What is the Soviet view of limited war? Briefly, war is an unending state. It is big or it is little, it is hot or it is cold, it is in the rice paddies and casbahs or on the battlefield, depending upon the political needs of the hour and of the day and how they fit into the over-all pattern of relentless Soviet-inspired aggression. Limited war is the more normal, as I see it, and the more likely type of war that I believe we will have to cope with.

FINALLY, what must the Western world do about limited war? We must respond rapidly—this is of the essence. And we must have *mobility*, whether by air or sea, and it will certainly take both. We must have means adequate to the task. And if there is any doubt about the type of opponent with whom we must deal, I refer you to the display in Red Square on last November 7th. Combat concepts of World War II or Korean vintage will be disastrous.

We must think of tomorrow and the needs of tomorrow, and these spell out in simple terms great dispersion and great mobility with surface-to-surface missiles extending the range of ground fire hundreds and hundreds of miles,

> *"Today the U.S.S.R. has in outer space encircling the earth, a satellite. In the future, additional satellites will be launched, and soon they will clearly have a military reconnaissance capability.*
>
> *"Such a military satellite, matched to an ICBM inventory, will be an impressive weapons system. The possession of such an ICBM-satellite weapons system will bring us to a period of hair-triggered existence, a period in which the future of our people may well hang by a thread, and a slender thread it will be."*

surface-to-air missiles to guarantee the independence of operations on the surface of the earth, and, finally, nuclear weapons in every echelon of the military establishment where they can be usefully employed—nuclear weapons of precise yield, small in size where necessary, and in abundance.

All the foregoing must be matched with significantly greater mobility than anything we have thought of in the past. For it is in mobility that innovation will be found. Tactical and strategic innovation is as essential to survival as the hardware of combat itself. This obviously is quite an order and suggests clearly a sizable investment of our national product in weapons systems. I wish that I could counsel some other course. I would prefer to do so if I could in all honesty, but I cannot.

There are but two aspects of this problem that I would like to touch upon very briefly before concluding. The first deals with Korea, and the second with the limitations of limited war itself.

One occasionally hears the expression, "We will never fight another Korea," or at least, until recently one frequently heard it in the Pentagon. I am not at all sure what is meant by this expression, nor am I sure that the people who use it are. Certainly one can understand the reluctance of the American people to fight a similar action at such appalling loss of life with so little to show in the way of decisive achievement. We are understandably reluctant to expose ourselves to that kind of experience again.

HOWEVER, there is another side to this problem. From the viewpoint of the technician and military professional of the West we certainly do not want to fight another Korea. We do not want to be in a position, for lack of air mobility, of having to send a few hundred men to meet a half dozen divisions, well equipped with armor and the latest Soviet ground weapons. Nor do we want to be forced to use World War II tactics and World War II equipment because of an inadequate research and development and modernization program in our Army following World War II.

*"The Cordiner Report had for its objective the improvement of the efficiency of our armed forces for ensuring benefit among the officers and men of the services. The failure to support the recommendations . . . will result in an enormous financial loss to the United States, for these men have been trained and educated at a cost of many thousands of dollars each. . .*

*"The discussions which we are listening to today are emphasizing to all of us the importance of the highly trained and supercompetent individual and organization. This requirement is the same in every service. We simply must have the best. This is not only true among the technicians, but it is true in the command posts. The leader of today, whether he be a noncommissioned officer, a company officer, or a higher commander, must be thoroughly trained. We cannot have an efficient military organization if the commander depends upon technical experts for his controlling decisions. He must understand its capabilities and limitations. . .*

*"If the principles of the Cordiner Report are not adopted promptly, where will we find the General Gavins of the future? Secondly, where will we find the trained subordinates they need for maximum success? If there is one thing that we all know we need if we go to war, it is success. I don't think we should throw it away by not taking action on something that is long overdue."*—LIEUT. GEN. LESLIE R. GROVES, vice-president, Remington Rand Division, Sperry Rand Corporation, in introducing General Gavin as the principal speaker at the luncheon session of the Thirty-ninth Annual Industrial Preparedness Meeting of the American Ordnance Association held at the Waldorf-Astoria, New York City, December 4, 1957.

We do not want to fight a first-class enemy on his terms, and this is saying a great deal when we realize that the Soviet Army today is the largest and best equipped, including missiles of adequate ranges, of all the armies in the world.

In this sense, we do not want to fight another Korea. If we are committed, we want to be allowed to have the weapons that we need to gain decisions swiftly; otherwise we will have another Korea multiplied many times.

The second point deals with the limits of limited war itself. Our policy appears to be one of containment. The weapons systems created to serve policy, therefore, must in themselves serve containment. If the Soviet military thinking matches our own, then a policy of worldwide readiness for limited wars would be valid.

But it would be foolish to presume that the Soviets are interested in limited war to the exclusion of other concepts. Quite the contrary, their armed forces are an instrument of a nation dedicated to worldwide conquest.

Sooner or later we must face up to this fact—we must be *for* something more than merely "against Communism," and our weapons systems must reflect what we are for.

Obviously, they must have a capability of doing more than merely dealing with limited war. There are limitations on limited war, and capability to deal with limited war must not exclude from our thinking the need for far greater capability. In fact, even today a capability to wage limited war successfully can only be valid within the over-all capability to wage and win a general war. Without this, the theory of limited war has little meaning.

In my personal belief, our Nation is entering an extremely critical period. The solution to the limited-war problem, which is obviously compelling and urgent today, is but part of our problem. We must know what we are for, as well as know what we are against, and create the weapons systems to serve our goals.

This will take hard work and great sacrifice over many years. Only thus will we earn the right to survive. Our forefathers gave us our liberty, but not necessarily the right to it. This right we must earn by our deeds today.

# Military Air Transport

*We need both long-range carriers and rugged assault aircraft*

Dr. Hall L. Hibbard

IT is quite apparent that manned aircraft, in a variety of forms and types, are vital to the successful waging of distant wars in modern times. We can foresee no end to the need for manned aircraft in such an environment. Although guided missiles will surely assume an important place in the battle complement, there will remain many functions which can only be carried out by aircraft under the direct and intimate control of human crews.

Let us make several assumptions, which we believe to be realistic, for the purposes of this discussion. First, any limited war will certainly involve the use of high-explosive or conventional weapons, will probably include small nuclear weapons, and will have a smaller chance of encompassing very large yield weapons. Secondly, although some brushfire wars may be put out by the use of airpower alone before they get well started, the majority will involve the use of land, sea, and air power in various proportions. Thirdly, a vital element in the success of the U. S. and its allies will be the speed with which forces can be built up and deployed in the theater.

Military aircraft which are directly used in conducting a war can be divided into two main classes: combat aircraft, which do the actual shooting, and support aircraft, which do everything else.

Probably the most vital of all support functions is that of logistics, defined for the purposes of this discussion as the transport of men and materials toward the battle area. We should like to focus attention first on this activity.

The aircraft industry views the transport of military personnel and cargo as big business, and the competition to design the best aircraft for the purpose is keen, to say the least. This is more than an effort to lead in satisfying existing requirements or specifications; it is also an effort to assist the military in defining the requirements so as to yield the best possible over-all results. So-called operations-research studies are made to find the least expensive system—machines and accessories—for accomplishing a given mission. Below are the results of a recent study of the subject.

ASSUME that the mission is to deliver within a few days the initial deployment and temporary supply requirements of a ground force or air task force to any theater in the world.

Fuel and oil supplies are assumed to be stored in advance at large friendly overseas airfields, but everything else must go by air.

The type of ground force to be delivered can be the new Rotad division, which has been specially organized and equipped for mobility. Likewise, a mobile air task force which has been packaged for ease of airlift can be assumed.

An analysis of present and probable near-future airfield locations throughout the world shows that friendly airfields with long, hard-surfaced runways are available within 1,000 miles of any theater where there is likelihood of a war. A comparison of various combinations of air delivery systems leads to what may seem like a very conventional conclusion.

THE most economical system needs two types of aircraft: first, a long-range airplane to operate from the U. S. to the well-prepared airfield nearest the theater; and, secondly, an assault transport to operate from there into the battle area, where only hastily prepared or unprepared runways can be expected.

Some of the aircraft should be especially equipped as tankers for movement of fuel within the theater. However, much of such movement is expected to be by surface vehicles which in turn have been carried into the theater by air.

The two kinds of logistics aircraft mentioned above—long-range and assault transports—have been analyzed for the best characteristics to fit the task and the environment.

First let us consider the long-range transport. Extreme long-range capability is not necessary because of the availability of intermediate stops in crossing the oceans. A time and motion study of routes indicates that the ranges needed are little greater than many commercial transports flying today.

The over-all system cost appears insensitive to flight speed of the long-range transport. Both in comparing the propjet with the turbojet and in varying the speed within these types, various offsetting factors give the designer a very free hand in selecting the power plant and designing the airplane. Likewise, the design payload weight of the airplane has little effect on system costs, within fairly wide limits.

*Dr. Hibbard is a senior vice-president of Lockheed Aircraft Corporation, Burbank, Calif. He was assisted in the preparation of this paper by James E. Lipp, director of development planning, Lockheed Aircraft Corporation.*

With wide design freedom available, we favor the medium-sized aircraft over the heavyweight in order to gain flexibility of operation under the great variety of circumstances that arise in limited wars.

A prosaic but important factor is the fuselage geometry. The cargo space, particularly the fuselage width, must be arranged around the size of equipment to be carried, and ease and speed of loading must enter the design from the outset; otherwise efficient use of the airplane is not possible. Conversely, the study has revealed several types of noncombat equipment which should be redesigned to favor the airplane.

Before leaving the subject of long-range cargo transport aircraft, it is desirable to take a look into the more distant future of this type. It is our opinion, based upon considerable analysis, that logistics by air is one of the most promising applications for nuclear propulsion. A development of this kind would eliminate the need for intermediate staging stops as well as reduce greatly the overseas fuel-storage requirements.

Some of the technical problems are difficult, and the aircraft will necessarily be large. However, thorough engineering studies and preliminary designs show that the development will be feasible. No highly unconventional designs are needed; in fact, the airplanes will look very much like some of the logistics aircraft that are flying today. We are confident that a nuclear-propelled logistics airplane will be developed sometime during the next decade.

In a similar vein, any vehicle which must operate far from home, whether by land, sea, or air, can benefit from nuclear power and its freedom from refueling. A rolling conversion from chemical to nuclear power in the vehicles of limited warfare will surely occur within our lifetime.

NOW perhaps a few words on the assault transport are in order. As mentioned previously, the transfer point for men and cargo from the long-range transport to the assault transport may be 1,000 miles from the battle area. The assault transport must be able to make a round trip at this distance; that is, it must have an operating radius of 1,000 miles or a range of 2,000 miles.

The assault transport also must be able to carry all the equipment items that determine the fuselage design of the long-range transport. In addition, it must be able to handle parachute drops and special unloading problems.

Finally, of course, the ability to operate in and out of unprepared terrain is a necessity. This includes a soft landing gear, plenty of thrust to roll on soft ground, and an ever-improving short take-off and landing capability.

All the special features described above mean that the assault transport must be nearly as large as a minimum-sized long-range transport. The advantage of the shorter required range is offset by the weight of special landing gear, more rugged structure, and provisions for short take-off and landing.

ALTHOUGH it is possible that both the long-range transport and the assault transport can be developed around the same basic frame, there are sufficient operating differences so that a given identical airplane cannot economically fill both rôles. Therefore, two separate, but possibly related, models will be required.

You may be sure, if any reassurance is needed, that the aircraft industry will do everything in its power to advance the state of art in logistics aircraft and to provide whatever number of such aircraft the military forces will require. This is a case in which the national interest, paramount in our operations, tends to encourage our industrial self-interest. There is, in fact, no more im-

portant area in the whole realm of national defense.

At the start of this discussion, another major category of airplanes was mentioned—combat aircraft. One can visualize all sorts of fighting craft over the battlefield or over the enemy's centers of supply, ranging in size and potency from the heavy bomber down to the proposed flying jeep. We should like to call attention here to a type which is in danger of being neglected but which will most likely be needed. This is a small battlefield attack airplane.

It is quite obvious that missiles are taking over much of the battlefield bombardment task, and this trend can be expected to continue into the future. Nevertheless, the battle forces are becoming more dispersed and mobile with each passing year, as witness the development of the Rotad-Pentomic division. Targets of opportunity, of short duration, will become the rule, and old methods of target evaluation and strike planning will become obsolete. Armed reconnaissance in the air will become a frequently practiced art, with more and more authority for attack being delegated to the pilot.

IN this environment, the weapons and aircraft to carry them must be matched with the target as well as with the basic purposes of the war. You will recall an assumption, early in this paper, that both conventional and moderate-yield nuclear weapons are apt to be used in future limited wars.

Progress in atomic weapons has greatly reduced the size and weight of A-bombs necessary to produce a few kilotons' yield, as compared with the heavy weapons used over Japan. It is now possible for a very small aircraft to carry a truly lethal bomb.

*"Logistics by air is one of the most promising applications for nuclear propulsion . . . A development of this kind would eliminate the need for . . . staging stops."*

Imagine, if you please, an airplane having a vertical take-off and landing ability, a top speed of 400 to 500 knots, a combat radius of several hundred miles, and the ability to deliver either conventional or small atomic weapons. Preliminary studies indicate that such an airplane can be built to have an empty weight of 5,000 pounds; that is, about 60 per cent of the empty weight of the old F-80 fighter.

Included in the equipment aboard would be a radio communications system for contact between the airplane and various ground or air control points, an inertial navigation unit which would be secure against enemy detection or jamming, and an infrared system for nighttime location of targets. We believe that an all-weather attack capability would be too complex and heavy to be incorporated in a small airplane of this kind in the very near future.

A corollary to this discussion of a battlefield attack airplane is the need for a continuing, active program for the development of conventional weapons. We know that the Atomic Energy Commission is pursuing a rapid improvement of atomic weapons of all sizes. Somehow the military must find the means to pursue a parallel course with nonatomic weapons. Likewise the means for ever more accurate delivery of conventional high-explosive weapons must be pushed as hard as possible.

For aircraft which are large enough to carry all-weather navigation equipment, presentation of navigation data to the pilot over the battlefield under conditions of poor visibility has been a complex problem. In this area there is now a real ray of hope. A recently declassified development being sponsored by the Navy is called the contact analogue system in which the pilot sees a presentation on a flat TV tube, rather than being required to interpret dozens of instrument dials.

Input data from altimeters, radars, and other instruments are integrated and displayed on the screen so as to construct an artificial duplicate of the actual scene ahead of the airplane. The pilot then goes ahead and flies just as if he could see. We anticipate that this system will find wide application and will be particularly valuable at low altitude over rough or complicated terrain.

OUT of these loosely related comments on logistics and battlefield aircraft it is possible to draw several general thoughts.

First, the state of the art of development of manned aircraft is going ahead rapidly and usefully, and will prove particularly significant in limited warfare over the remainder of this century at least.

Secondly, the airplane strongly affects and is affected by the forces and equipment that it must carry. This mutual interaction must be continually borne in mind if the best over-all result is to be obtained.

Thirdly, we see a substantial increase in conventional airlift available to the various combat forces as a major need in preparing for limited war.

Finally, the changing environment of limited war in the atomic age will open up new uses for aircraft that should be explored as rapidly as they appear.

**The giant Globemaster is a good example of long-range transport (Air Force photo).**

AMERICAN ARMAMENT, IV

# COMBAT AIRCRAFT

## OF THE UNITED STATES ARMED FORCES

*An outline of the operational aircraft employed in combat by the U.S. Air Force, Navy, Marines, and Army, designed by engineers and scientists of the armed forces, educational institutions, and industrial organizations and produced by American industry for the national defense.*

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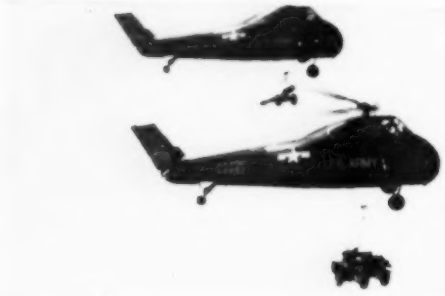
ORDNANCE

*Bimonthly Journal of the American Ordnance Association*
Washington 6, D. C.

# ARMY Helicopters

Army H-34 high-capacity helicopters, below, produced by Sikorsky lift 106-mm. BAT weapon and 75-mm howitzer. Same as Marine Corps HUS assault helicopter that carries 12 equipped men.



Army TH-41 light reconnaissance 4-passenger helicopter, left, built by Cessna, now under test for gunfire-observation missions.

Army H-21 Shawnee single-engine, twin-rotor craft, left, built by Vertol, carries 10 to 15 troops or 3,000 pounds. Speed 100 knots, range 200 miles. Can carry armament.

Army YHU-1 Iroquois (Bell H-40) gas-turbine-powered observation and liaison craft, left, to replace H-19.

# NAVY Antisubmarine Aircraft

Navy HSL-1 Bell antisubmarine search helicopter operating with dipping sonar. As part of our "hunter-killer" forces, it is equipped with underwater homing weapons.

P5M-2 Martin Marlin, 250-knot seaplane f
marine work (top, below). Carries after tw
gun turret, underwater weapons, powerful s

P2V-7 Lockheed Neptune 300-knot land-
trol bomber for antisubmarine search a
with long range and endurance (center, be
derwater homing weapons. Can also l

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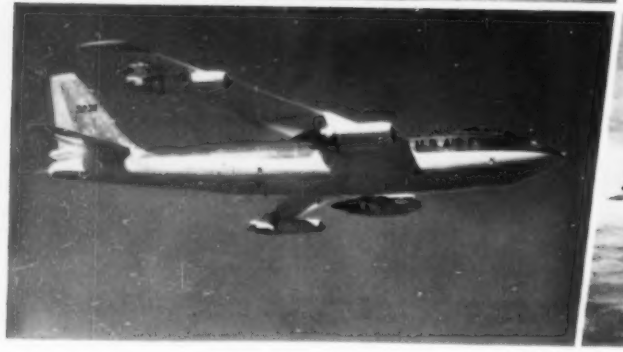

# AIR FORCE Bombardment Aircraft

B-47 Boeing Stratojet 3-man SAC bomber. Has 1,500-mile range extended by air refueling. Speed, 600 m.p.h. Ceiling, 40,000 feet. Armament, 20-mm. cannon, nuclear bombs or Rascal missile.

B-52 Boeing Stratofortress 6-man SAC heavy bomber. Range, unlimited with refueling. Speed, 600-plus m.p.h. Ceiling, over 50,000 feet. Armament, 20-mm. cannon, largest nuclear bombs.

B-66 Douglas Destroyer 3-man, 2-engined tactical bomber. Speed, 650-plus knots. Can be equipped for high- or low-level strikes armed with 20-mm. cannon, small atomic bombs.

## NAVY Attack Aircraft

lane for antisub-
er twin machine
rful searchlights.

land-based pa-
rch and attack
er, below). Un-
lso lay mines.

S2F-2 Grumman Tracker, carrier-based, twin-engined craft for hunter-killer work (top, below) to replace 2-plane teams. Can carry largest underwater weapons.

ZPG-2 Goodyear semirigid airship for antisubmarine search and attack (center, below). Speed 71 knots, great endurance, holding record of 264 hours without refueling. Some equipped for early warning.

A3D Douglas Skywarrior 3-man carrier twin-jet attack aircraft (top, below). Speed over 650 knots, carrying 20-mm. cannon, bombs, or air-to-air missiles.

AD-6 (top) and AD-5W Douglas Skyraiders, carrier-based single-engined attack aircraft (center, below). Fleet workhorses, successors to earlier AD types. Subsonic speed but carry heavy payload of armament.

A4D Douglas Skyhawk one-man, carrier-based attack-bomber. Speed, over 700 knots with single J-65 jet engine. Smallest atomic-bomb carrier. Armed with 20-mm. cannon. This plane is latest attack type for new FORRESTAL-class carriers.

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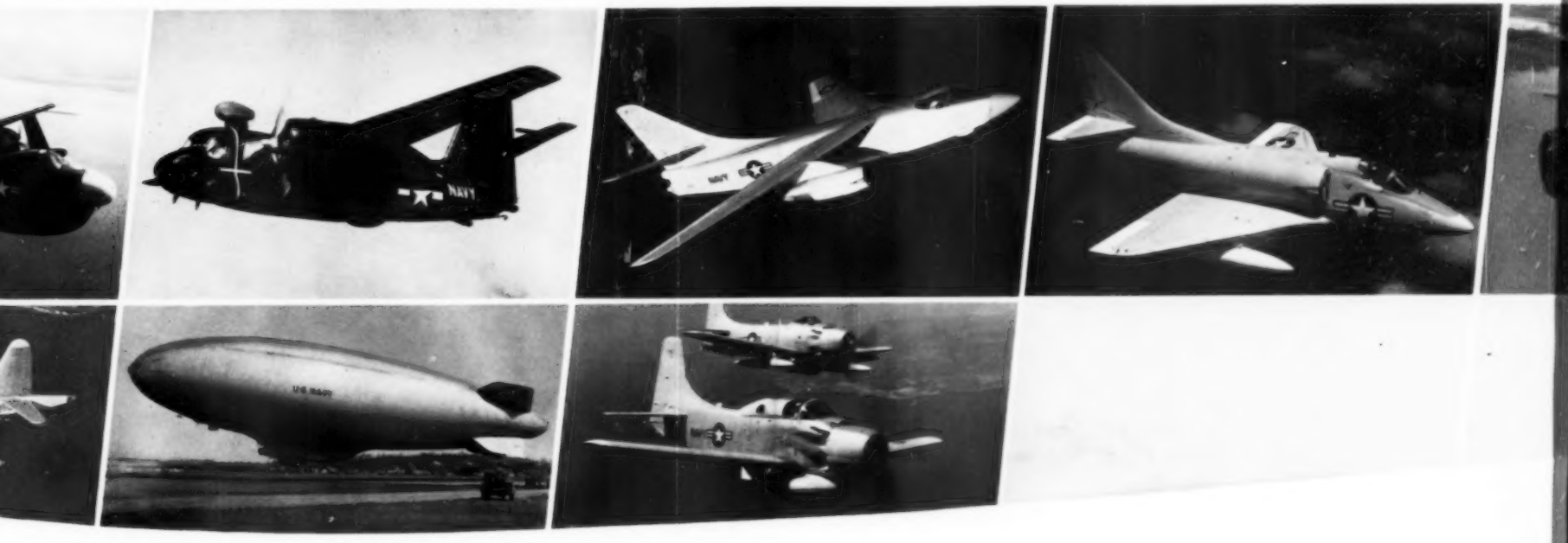

# BAT Aircraft of the United States Armed Forces

## AIR FORCE Fighter Aircraft

B-58 Convair Hustler, with 4 engines and 3-man crew, is our first supersonic jet bomber with ceiling well over 50,000 feet. Armament unknown, believed to carry large payloads.

F-101 McDonnell Voodoo twin-jet fighter. Armament, air-to-air Falcon missiles or atomic bombs. Holds latest official world speed record of 1,207.6 miles an hour.

F-104 Lockheed Starfighter is supersonic with exceptional climb and maneuverability characteristics. Now in production. Can be equipped to carry air-to-air missiles or A-bombs.

F-100 North Ame
supersonic Centu
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## Attack Aircraft

## MARINE CORPS Helicopters

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A4D Douglas Skyhawk one-man, carrier-based attack-bomber. Speed, over 700 knots with single J-65 jet engine. Smallest atomic-bomb carrier. Armed with 20-mm. cannon. This plane is latest attack type for new FORRESTAL-class carriers.

Marine Corps HOK-1 Kaman 4-place, piston-engined helicopter for observation, rescue, and liaison missions. It is an essential adjunct of division headquarters to speed up flow of battlefield information. Contrarotating rotors are superimposed in pairs.

Marine Corps HRS-3 Sikorski assault
Either carrier- or land-based, it is employed
envelopment behind a beachhead to impleme
amphibious-warfare tactics. It can carry 12
combat troops in addition to pilot an

# he United States Armed Forces

● The U. S. Air Force, Navy, Marines, and Army are equipped with aircraft capable of either attack, defense, reconnaissance, or rescue far forward in the combat zone. The Air Force is principally responsible for strategic bombardment, tactical air support, and continental air defense. The Navy has aircraft of similar types suitable to the variety of missions to which it may be assigned, with special emphasis on undersea warfare. The Army's helicopters, some of which can be armed, reconnoiter and carry troops and supplies almost to the front lines. These illustrations are from official service photos.

## CE Fighter Aircraft

-jet fighter.
missiles or
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s an hour.

F-104 Lockheed Starfighter is supersonic with exceptional climb and maneuverability characteristics. Now in production. Can be equipped to carry air-to-air missiles or A-bombs.

F-100 North American Super Sabre, the first of supersonic Century Series. Armed with 20-mm. cannon. Types D and F classed as fighter-bombers and can carry A-bombs. Speed, 822 knots.

F-102 Convair all-weather supersonic interceptor. Ceiling, over 50,000 feet. Of special interest to Continental Air Defense. Primary armament, Falcon missile or Genie rocket.

# NAVY Fighter Aircraft

sault helicopter. ployed in vertical nplement Marine arry 12 equipped lot and copilot.

F11F-1 Grumman Tiger supersonic high-altitude fighter going on FORRESTAL-class carriers (top, below). Armament, 20-mm. cannon and air-to-air missiles.

F8U-1 Chance Vought Crusader supersonic day fighter (center, below) is being added to defenses of FORRESTAL carriers. Is armed with 20-mm. cannon, rockets, or air-to-air missiles. Clocked at 1,015 m.p.h.

F3H McDonnell Demon in the F3H-2N class (top, below) is an all-weather carrier fighter armed with 20-mm. cannon and Sidewinder air-to-air missiles.

F9F-8 Grumman Cougar fighter (center, below) is standard equipment in ESSEX-class carrier squadrons. Armament, 20-mm. cannon and rockets, light bombs, or Sidewinder air-to-air missiles.

The F4D Douglas Skyray supersonic jet all-weather fighter-interceptor (top, below) is armed with 20-mm. cannon, air-to-air missiles.

F3D Douglas Skyknight jet fighter-bomber used by Marines in Korea (center, below). Mostly replaced by the FJ4-B McDonnell Fury and other heavily armed aircraft.

F-94 Lockheed Starfire all-weather jet interceptor, together with F-86D and F-89, backs up air defense until more Century Series fighters are available. Armament, usually 2.75 rockets.

F-89D Northrop Scorpion twin-jet, subsonic, all-weather interceptor. This type carries 104 rockets (2.75-in.) in wing-tip pods. Others carry Falcon missiles and fewer rockets.

F-105B Republic Thunderchief fighter-bomber, one of the latest supersonic jets, is scheduled for Tactical Air Force Striking Groups. Armament, probably air-to-air missiles or atomic bombs.

# Rôle of Guided Missiles

*While the Army's ground-launched weapons are effective today, much more development is required to improve their range, accuracy, and reliability and to make them suitable for use in limited warfare*

Dr. C. C. Furnas

QUITE apt analogies are often drawn between warfare and the game of football. The present military situation offers such an opportunity for comparison. Long-range strategic bombing is comparable to the 50-yard touchdown pass. Limited war may be likened to the quarterback sneak. If our plans and deployment are concentrated entirely on long-range passes, the opponent may take full advantage of the situation and readily achieve victory through unopposed short thrusts on the ground.

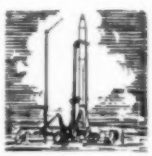
The *Wall Street Journal* on November 11, 1957, expressed the situation in more realistic terms:

"THE Russians are talking at the top of their lungs about their budding capacity to launch a push-button war. But they and their Chinese partners are quietly devoting the bulk of their resources to preparations for an utterly different kind of war. Nikita Khrushchev is proclaiming, for instance, that the missile has doomed the piloted warplane. Yet today Russia is outproducing the U. S. severalfold in light bombers and fighter planes. It is maintaining enormous troop forces and giving its army the most modern tanks, artillery pieces, and huge and highly mobile helicopters. It is training its soldiers in the maneuvers of 'tactical' atomic war."

It has become quite clear that, whatever the cost in effort and dollars, we must be equipped and prepared to fight limited as well as global wars.

*Dr. Furnas is Chancellor of the University of Buffalo, Buffalo, N. Y.*

Nuclear weapons, guided missiles, and the growing effectiveness of air transport have radically changed the planning and tactics of ground warfare —which almost certainly will be the key operation of any limited contest. Emphasis is necessarily placed on dispersal of men and equipment, on fluidity, and on a high degree of mobility of both personnel and matériel. Guided missiles inherently are ideal for quite extensive use in this sort of situation.



In most of the limited-war conditions in which we can conceive America might become engaged in the future, it is almost certain that at times our troops will be greatly outnumbered. It will be necessary to deploy our men and equipment to almost any part of the world very rapidly. Further, our supply lines will be very long. This could lead to very severe logistic problems if we should have to transport masses of equipment.

Unless we can maintain a family of weapons systems that are substantially more effective than those of any enemy, we will find ourselves in very awkward if not untenable situations. Hence it is most essential that the development of guided missiles for limited war be pointed toward achieving the greatest possible capability in (1) increased effectiveness per man, (2) increased effectiveness per pound, and (3) extreme versatility in order to cope with a great variety of situations with a limited number of types of missiles.

My discussion will necessarily be limited in scope. It will not include unguided rockets, such as Honest John, even though those weapons do have a certain utility, at least for an interim period. I will confine myself to the ground-launched guided missiles in the domain of the ground forces.

I define the guided missile as an unmanned weapon which is subject to control after it has been launched. This control may be completely internal to the missile or it may be exercised through a command link to the missile from some external source.

The ground-launched guided missiles presently available for Army use are:

1. *Dart*—a limited-range, wire-guided missile designed particularly for antitank use.

2. *Lacrosse*—a highly accurate missile carrying a very substantial warhead, electronically guided to the target by a forward observer.

3. *Corporal*—a 75-mile-range ballistic missile with inertial guidance.

4. *Redstone*—a 200-mile-range ballistic missile with inertial guidance.

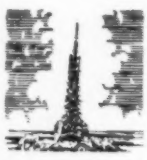
5. *Nike Ajax* and *Nike Hercules*—electronically guided antiaircraft missiles for medium- to high-altitude targets.

6. *Hawk*—an electronically guided low-level antiaircraft missile.

These six make up the first generation of a well-balanced and effective family of missiles, carefully planned for fulfilling the Army's function. But these developments are not static. The family lines will evolve and grow in effectiveness through the research and development route.

Toward what areas of improvement should the Army's program be directed to meet the needs of limited war?

Every engineer likes to design his equipment to the peak of perfection and to limit its operation to the optimum design point. This leads to a spate of multiple types of everything from automobiles to guided missiles. This tendency toward proliferation through specialization will be particularly undesirable for limited-war equipment. It is not primarily a matter of cost of development and production of many types but of the best utilization of limited manpower and limited weight-carrying capacity.



Modern equipment is so complicated that each missile type requires a specialized crew, thoroughly trained down to the last detail. The more types of missiles, the more highly trained men we must have, even though the total firepower is not increased by the greater number of types. The fewer the component parts, the simpler the logistic problem, not only in terms of weight to be transported, but also in terms of saving time.

WITHIN limits, the necessary versatility of the Army's family of guided missiles will be promoted by keeping the number of types to a minimum. Obviously this is a very complicated problem and one which requires careful analysis. A new, comprehensive, and basic operations research study would probably be fruitful in setting up guide lines for future developments.

By sacrificing some peak efficiency and by other compromises, it should be possible to make certain improvements in versatility of missiles by increasing the spread of operating ranges. Ordinarily little attention is given to making the ratio of the maximum to minimum range of the system as great as possible. In the interest of the necessary versatility for limited wars, it is important to develop this capability to the highest practical limit.

The virtue of reliability of performance of the mechanical and electronic components of missiles is obvious. Although no one ever denies the necessity of improving reliability, it is an area of development that seldom receives adequate attention. Major effort should be put on this phase continuously.

Even the simplest missiles are still undesirably complicated for G. I. operation under battle conditions. Something which seems very simple to a development engineer may be very complicated indeed to the soldier under fire. Much careful thought and design effort should be put into simplifying the tactical missiles.

Accuracy in striking the target is very closely linked to reliability, but it has unique problems of its own. Substantial improvements can be made, and they should be pursued vigorously, because inaccuracies can have very deleterious effects on the complete military operation.

For instance, if the objective is a point target, doubling the circular probable error may mean that the number of missiles required to accomplish the mission will be quadrupled. As in tennis, golf, or baseball, the accurate performer wins.

There seems to be a growing feeling that the availability of atomic warheads decreases the need for accuracy. Such a conclusion is not warranted for the limited-war situation. In a widely dispersed and mobile battle area there often will be a complicated mixture of friendly and enemy areas. The very lethality of atomic warheads will increase the importance of placing the weapon on the enemy target and not among friends. There will be a very small margin of allowable error.

Several of the Army missiles have electronic guidance systems. This makes them susceptible to jamming by enemy electronic countermeasures. Further, they are vulnerable to jamming by the electronic interference of friendly equipment. Modern warfare is a complex and fiercely competitive electromagnetic-radiation jungle.

No really complete and realistic tests have yet been conducted to determine how susceptible missile guidance systems will be to friendly or enemy jamming under battlefield conditions. Such tests and evaluations are very badly needed. We can never feel comfortable about the battleworthiness of our missile systems until such comprehensive evaluations have been conducted.

HOW much degradation of performance will our weapon systems as a whole suffer under real battle conditions? In so far as is humanly possible we must determine the facts quantitatively before we can design and deploy new guided-missile systems with any degree of confidence.

If the performance data coming from the type of realistic evaluation I am proposing turn out to be on the grim side, we may have to make major revisions in our guidance approach.

Will the "all-inertial" guidance systems be the only ones that are reasonably jamproof? Will some entirely new approaches to the guidance problem have to be utilized? Are there any areas of basic research in guidance and control which are being neglected?

Solid-fuel research for missile propulsion has advanced substantially during the past few years. Although solid propellants probably never will achieve the specific impulses realizable with the best liquid-fuel systems, it would seem that the Army should aspire to adapt solid propellants to all its guided missiles.

The simplicity, battle-readiness, reliability, and uncomplicated logistics of solid propellants outweigh the modest advantage of the somewhat greater thrust efficiency of liquid-fuel systems. Continuing basic research on solid propellants is highly important.

Although a future limited war may, for a time, settle down to a contest with more or less fixed positions, the

side which has the greatest potential for missile mobility will certainly have a distinct advantage, particularly if it has control of the air. The need for a high degree of mobility obviously puts a premium on light weight, not only for the missiles themselves, but for launchers and all other ancillary ground equipment. The means of transport may be by aircraft, by jeep, or on the back of a man. None of the possibilities should be overlooked.

Ability to break the equipment down into units of small weight is obviously important. Methods of rapid disassembly and reassembly take on added significance in mobile situations. Interchangeability of parts is fully as important here as it is in the automobile business. These items involve a host of development problems which are being worked on but which deserve a higher position on the priority list than they now have.

The requisite versatility of weapons for limited wars depends to a major extent on having both high-explosive and nuclear warheads available. Since low-yield nuclear warheads are now obtainable in light weights, it is particularly important that each of the missiles be developed so it may use warheads of either type.

THERE is always a great temptation to develop a new missile or a new model for each warhead. In the interest of over-all simplicity and effectiveness, this tendency to make major changes for minor reasons should be strongly resisted.

The very best weapons are essentially useless unless the target can be detected and located with considerable exactness. Some truly major improvements are needed here. A heavy emphasis on basic research might lead to new methods of detection.

Our present equipment for reconnaissance by visual, radar, or infrared methods is inadequate. Improved, high-speed drone aircraft which could survey enemy terrain at low level in all weather conditions would be very helpful.

It is certain that in future wars the mobile and fleeting target will be more important than ever before. Missile systems, to be effective, must be capable of going into action very promptly after the detection of a target, whether it be ground-based or airborne. Promptness involves doctrine and organizational details as well as equipment design, but these are all essential parts of the improvement patterns for missile systems. More than ever before, delays can be fatal.

*"Within limits, the necessary versatility of the Army's family of guided missiles will be promoted by keeping the number of types to a minimum. Obviously this is a very complicated problem and one which requires careful analysis. A new, comprehensive, and basic operations research study would probably be fruitful in setting up guide lines for future developments."*

Though I have decried the trend toward increasing the number of missile systems, one must be certain he has covered all functions before he can be sure that he has the situation well in hand. What gaps are there in the present program?

The present arbitrary 200-mile-range limitation on Army missiles would seem to be an unnecessary and undesirable handicap. Without entering into the rôles-and-missions argument on strategic bombardment, one can certainly see that the ground forces' function in modern war could often reach out farther than 200 miles from the missile launching point.

Whether it be a new missile or one of the almost-available IRBM's, something with a range of several hundred miles would appear to be needed for the Army's arsenal.

AN effective counterweapon to ballistic missiles in the battlefield obviously would be nice to have. The Army's study program, Plato, is directed toward meeting this need. Though the optimists assure us of ultimate success, a reasonable skepticism is justified. A weapon which would effectively counter a ballistic missile would be the most difficult development of all time. But a successful result would be so important that the project should be pursued vigorously.

The ideal would be a single system that would adequately counter all enemy targets overhead, whether airborne or ballistic. Here, again, more really sound basic research is badly needed.

This has been a brief, descriptive catalog of the research and development needs—as I see them—for the Army's ground-launched guided missiles for possible future limited wars. If my ideas seem unrealistic and too demanding, remember that in future engagements we are probably going to be outnumbered and outweighed by the enemy. Our only recourse will be to outsmart him.

AS a final point I should like to urge the use of very great discretion in the use of nuclear warheads if we should become involved in another limited war. If the United States should use one first, the negative propaganda impact on the rest of the world would be tremendous. We greatly underrated the propaganda value Russia might obtain from launching the first satellite, and we are probably belittling the worldwide sociological effect of using the first "tactical" atomic warhead. We should not fire it unless we are psychologically and physically prepared to go the whole way through World War III, if necessary.

Even if the nuclear war should remain in the "limited" category and be confined to small-yield weapons, the radioactive contamination would be extremely serious. After the first "tactical" nuclear weapon is fired in war, both sides almost certainly will employ them and use a great many of them in subsequent fighting.

The radiation hazard will mount—and very rapidly. Both civilian and military personnel in the entire region involved will be the victims—and the civilians often will include our friends.

In the present state of the world we can't afford to lose friends. Though we must be fully equipped and must maintain the atomic capability at all times in as many weapons as possible, certainly extreme discretion will be the better part of initial valor.

# Electronic Research

*An enormous amount of work still lies ahead if we are to develop into usefulness for limited war the many undeveloped possibilities of increasing reconnaissance and communication on the battlefield*

Dr. E. R. Piore

AT this point in history the notion of limited war is obscured by the enormous concentration we are giving the sputniks, ICBM's, and IRBM's. In order to bring this subject into the open once again, it is necessary for our military planners first to recognize its importance and then negotiate the proper budgetary allocations.

It is quite obvious that interest in limited warfare today has been minimized by current events; consequently very few technical persons of repute are presently concerned with its portent. There should be little wonder why the technical person in the laboratory has difficulty translating into research and development the vagueness and confusion which is so often substituted for realistic requirements.

In order to obtain support from the laboratories, there must be some serious and positive speculation in regard to limited wars. Definition is required as well as the determination of what we expect our forces to do with the hardware furnished them.

I AM primarily concerned by the fact that our Nation's posture is oriented toward the applications of nuclear weapons. If the world should experience future limited wars, we ought to achieve a capability which is not solely dependent on these weapons, as we may not have the opportunity of utilizing them.

*Dr. Piore is director of research and development for International Business Machines Corporation, New York, N. Y.*

In times gone by, weapons produced for the truly big wars were used with considerable effectiveness in the small interim and localized police actions, but this is no longer possible. We cannot safely live with the concept of achieving victory in a limited war by merely reducing the size of the push buttons controlling all-out war machines.

The individual man as transformed into a warrior must not be forgotten. Our systems philosophy should be concerned with providing him with weapons systems appropriately constructed for limited warfare. He must be allowed maximum flexibility and mobility if he is to remain in conformity with his immediate environment.

Today there is much talk about the mobility of our Redstones and IRBM's. However, before firing them it always appears that the surrounding countryside must be subjected to an astonishing metamorphosis if the weapons are to render maximum operational efficiency.

One of the major factors which will assist us in overcoming the problems associated with limited warfare is electronic research. The advent of solid-state devices has completely revolutionized the concept of the soldier and Marine as mere single firing units. The weight and power consumption of these new devices are relatively infinitesimal, and they ought to become quite inexpensive.

The equipment eventually allocated each man will be issued like K rations, and he will be permitted to throw it away without regard for material worth. Naturally there are many solid-state devices forthcoming other than transistors which will have a pronounced effect on electronic equipment in warfare.

ANOTHER extremely important category is that of the business of systems and data processing. In both our industrial and large business environments we understand how to cope with large systems. On the other hand, we have yet to resolve how to make the applications to small businesses or small situations. Once these methods are initiated our armed forces will be provided with increasing mobility. We will also be able to succeed with less men in the field and perform more effectively against our enemies.

In the past, all large systems used in war dealt with primary effects—in radar it was the direct reflection—but a start has been made in studying derivatives. The moving-target indicator is a case in point, although far more than this can be done on a research level. Work should be devoted to deriving

the maximum information from radio signals, whether they are our own, reflected from the enemy, or originated from a hostile force. In order to accomplish this, we must understand sound, various types of modulation of RF energy, and the sharing of RF frequencies for modular functions.

I WOULD like to point out here that our successful air-to-air infrared missile operates on derivatives, not on the primary signal. There is a tremendous amount of pay dirt in this entire research area which is not being exploited—and, indeed, not being energized with sufficient vigor and thought. An example of this is a company which announced recently to the National Academy that it had just evolved a new type of color reproduction system.

This type of invaluable speculation is bound to increase our sensory ability on the battlefield, but very little attention is being extended to the derivatives. You undoubtedly remember Taylor's Series from college freshman textbooks. In this case the most significant term was certainly not the first one.

The area of sound is one we have failed to use thoroughly. Again I refer to secondary effects and derivations. Presently we do not detect aircraft by sound, since planes move with the velocity of sound. However sound travels quite rapidly in the ground and we should have the ability to detect moving vehicles and of obtaining a knowledge of terrain behind the enemy's lines. A vast amount of work is required in geophysics in order to analyze and understand various types of terrains. Hardly any work is now under way which will produce a better knowledge of geophysics around the earth. This is a tremendously important subject which once more involves the rôle of electronic research in preparing us for a possible limited war.

AN enormous amount of work and pay dirt still lie ahead in regard to readiness for limited war. In order to initiate and accomplish successfully the innumerable tasks which await us, we must have a sense of urgency, real need, and propriety comparable to that stimulating the output of all the magic weapons which we are constructing in competition with the Russians.

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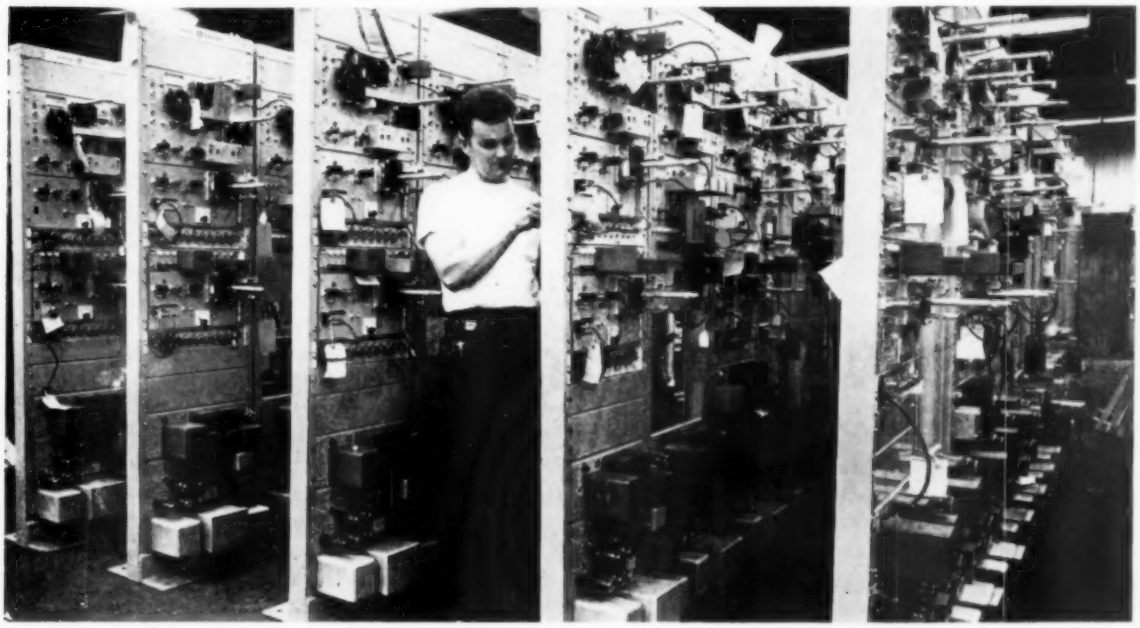
EDITOR'S NOTE.—The importance of electronics in modern weapons systems cannot be overestimated. Guns, rockets, and missiles of all types depend upon complex electronic devices for fire control and guidance, and the communication of data and other information in this regard also is dependent upon electronic equipment of many kinds.

*"Planning of military requirements for future weapons systems must be done by the integrated activity of the military, the scientists and engineers, and the industrial planner. . . . We cannot be content with limited views of our capabilities. We must take a bolder approach to the problem and shoot for the development of new weapon systems.*

*"The selection process should have a broader base and the research upon which this is all founded should cover a much wider area. It is not sufficient to base our development of large-scale weapons projects upon laboratory experiments. Rather, we believe it more prudent to give our scientists and engineers sufficient funds to test full-scale prototypes of several versions."*—ROBERT H. SHATZ, Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y., during the afternoon session of the A.O.A. Annual Industrial Preparedness Meeting at the Waldorf-Astoria, New York, December 4, 1957.

**Microwave radio-telephone equipment is being produced in large quantity for Army Signal Corps use.**



# Cost of a Dual Capability

*It may be more economical in the long run to provide strong tactical forces together with strategic deterrent power rather than to place all our reliance against possible aggression in the nuclear threat*

Malcolm W. Hoag

A "dual capability" can be defined as a military capability for fighting all-out wars or limited wars. Whether we can and should support a dual capability, however, becomes a real economic issue only if we desire different kinds of forces to fight these different kinds of war. However, if we limit war by constraining only its objectives, area of combat, and resource commitment, the same strategic air power that is our main deterrent to all-out war can be militarily effective in fighting limited wars.

A small strategic bomber force could be diverted quickly to fight in a limited war, and its attrition at the hands of the enemy would probably be negligible if used in areas not covered by the enemy's air-defense network. It need not remain vulnerably based in exposed forward areas, and, most important, its use need not detract from our general deterrent power.

The decision to use such a force would itself be the signal to bring the remainder of our strategic force to a higher state of alert, so raising our retaliatory capability.

But, of course, such a force can apply tremendous pressure only by using large nuclear weapons. If, for many good reasons, we want to avoid initiating the use of such terribly destructive weapons in limited wars, we need to be able to apply force much less violently, and with greater discrimination.

*Mr. Hoag is an economist with the Rand Corporation, Santa Monica, Calif.*

In short, we need land armies complemented by supporting air and naval tactical units as a second capability.

No one disputes our need to maintain a strategic air power capability, but some argue that we cannot also afford this second capability. To appraise their argument we must establish a sense of proportion about the military establishment we can afford and inquire about the likely cost of a realistic alternative to a dual capability.

There is so much talk, and such loose talk, about absolute budget ceilings being predetermined by the need to maintain a sound national economy, that this view must be disposed of first. For if we concede that we cannot afford to spend more than we are now doing upon national defense, but that more must be spent upon protecting our strategic air power and adding missiles to it, the issue of a dual capability seems to go by default.

A deceptively simple exercise in arithmetic then yields the conclusion that we can afford to spend less upon armies and their supporting units.

But while it stands to reason that we cannot neglect the potentialities of a mixed bomber-missile strategic force for ourselves, and must protect it much more adequately when the enemy's striking power is growing so vastly, the issue of its size and total cost is still open. And we can spend more upon defense in total if we are willing to sacrifice some nonessential though desirable civilian alternatives.

COMPARE the pattern of our national spending in 1956 with that in 1952. If the proportion of our gross national product devoted to national security purposes in 1956 (10 per cent) had been raised to the level attained in 1952 (14 per cent), the growth in national product over this period would have provided about $40 billion more in real terms for civilians despite an increase in defense spending of some $16 billion. Whether we ought to spend this much upon defense is an open question, but it is irresponsible to evade the issue by dogmatically asserting that the richest economy on earth, able to devote over two-fifths of its resources to defense in World War II, cannot afford to devote more than one-tenth of its resources to this purpose now.

Those who argue that we cannot increase our defense spending sometimes assert that higher government spending must increase the pressure upon resources and drive prices up, creating inflation. But whether the net pressure upon resources increases depends upon what we do simultaneously to curtail civilian demands. If, as one alternative,

we have the political courage to increase taxes, the net pressure need not increase.

There is a sophisticated argument that higher taxes will not offset the inflationary impact of higher government spending because higher taxes will reduce incentives to produce at the same time as they reduce civilian power to buy. Thus civilians may take a smaller slice of an unfortunately smaller pie, leaving no more for government purposes.

BUT this argument at best is plausible, not convincing. True, higher taxes lessen the material rewards from working, but they also make people less able to afford the pleasures of not working. The incentives to produce need not be impaired by higher taxes, especially if we design our tax structure to strengthen its favorable effect upon incentives.

So much for the prominent but largely false contention that we cannot spend more upon defense. The real issue about the cost of a dual capability is whether any alternative military posture promises us more defense for our money.

The prominent alternative is a strategy that concentrates our offensive capability upon strategic air power, an alternative that must be examined searchingly. Obviously it promises great economies from dismantling our tactical arms. But, more subtly, probably it promises great diseconomies also.

We must not overlook one great economy which is associated with our dual capability; namely, economy in air defense—especially in civil defense. We do spend a few billions per year upon the air defense of the United States—an impressive sum—but the amount spent upon radar warning, defensive missiles, and fighter airplanes could probably be multiplied severalfold without guaranteeing civilian invulnerability against enemy air attack.

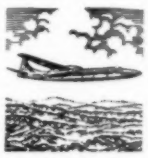
And while we might be able to add effective bomb shelters for most of our populace without doubling our current spending upon protection against air attack, protecting our industrial and associated facilities is a different matter.

*"We seem to have achieved an uneasy compromise between the dual capability and pure air-power alternatives . . . and we may be getting more of the disadvantages of each than their advantages."*

Putting cities underground is obviously vastly more expensive than providing emergency shelters only for people.

In brief, there is virtually unlimited room for additional spending that would reduce our vulnerability to enemy air attack, and we have chosen to stop far short of seeking invulnerability. The rationale of our policy is that the resources are better devoted to lowering the probability that the enemy will launch an all-out attack than to mitigating the consequences if he should attack. We seek primarily to deter the enemy, and to do so in two ways. We deter enemy aggressions because we and our allies can meet them with tactical arms or with strategic nuclear bombing.

Suppose we reserve strategic nuclear bombing to counter those aggressions that, first, are clear-cut in the sense both that there can be little juridical ambiguity about what constitutes aggression and very little chance that the enemy's provocative action could have been unpremeditated.



By definition such provocations are unlikely to trigger war accidentally, and our threat of massive retaliation may reduce to very small proportions the probability of their occurring deliberately. With a resultant very low probability that a provocation of this nature will occur, we could reasonably plan to spend only moderate amounts upon protecting our civilians against air attack.

But notice what happens if we dismantle our dual capability and rely upon strategic air power alone to deter or defeat all aggressions, clear-cut or fuzzy, major or minor. We could not expect to deter the provocations that arise from lack of a common understanding of what would be regarded as aggression, from impulsive satellite action, or from simple accident.

Provoked in any of these ways we could either do nothing, so inviting further provocations masquerading as accidental ones, or we could attempt to force withdrawals by specific ultimatums backed by readiness to use strategic nuclear bombing.

But issuing such ultimatums is a game at which more than one can play and one which requires the most resolute political backing to play effectively. Dictatorships are better situated than we are to play this game because they are less responsive to the fears of their own people and less moved by humanitarian considerations.

Where we threaten retaliatory bombing, the enemy may counter with threats in kind, especially when he regards us as the aggressors in the ambiguous situation at issue. To avoid withdrawals which would cause "loss of face" and impair future bargaining power, each side would be sorely tempted to increase its threatened retaliation in order to make the other back down first. The strategic equilibrium becomes precarious.

Under these circumstances the possibility of economizing upon measures to protect our civilians against air attack is brought especially into question. The risk of total war probably rises if threats of massive retaliation arise from provocations almost bound to occur instead of being confined to provocations which, because they would be clear-cut, in all probability can be prevented from occurring. It becomes reasonable to spend more upon air-defense measures because it is more likely that they will be used.

AN exchange of specific bombing threats over other areas, with actual bombing in some cases to demonstrate that we were not bluffing, would increase our fears of air attack. Offsetting these increased fears in order to provide the resolute political backing needed for an extreme air-power strategy could be a staggeringly expensive job.

Reducing our physical vulnerability to offset the increased risk of attack by

some combination of more active defenses and even a modest approach toward underground cities can easily cost billions more per year. And, ironically enough, any dramatically big effort to reduce our physical vulnerability would itself advertise how seriously our government took the threat and would thus to a degree increase the very fear that our air-defense program has to overcome.

When one considers the air-defense implications of substituting strategic airpower for a dual capability, it is by no means clear that the substitute would be any cheaper.

Broadly speaking, we have a choice between two contrasting military postures, each of which is expensive. The one, concentrating upon strategic airpower as the deterrent, would economize on tactical arms; the other, stressing a dual-capability deterrent, would economize on air defense for our civilians.

The strategic argument for a dual capability is that it minimizes the risk of total war while permitting us to counter local aggressions. If we can deal effectively with such aggressions by tactical means that are clearly less violent and more discriminating in their application of force than strategic nuclear bombing, we are less likely to incite massive retaliation in reply.

Moreover, the associated combination of securely protected strategic air power and manifestly insecurely protected cities presents the posture least likely to encourage unreasonable enemy fears that we plan preventive war. Consequently the risk that he would take preemptive action by all-out attack because of such fears is minimized.

CLEARLY, the reverse combination of insecurely protected air power and securely protected cities on our part is the one most likely to provoke preemptive action by the enemy. If the enemy sees such a combination he can only conclude that we are terribly stupid or that we are planning to strike first with our bombers and missiles, and hence feel no need to protect them.

This is a terribly dangerous posture for us, for our intentions look fearsome at a time when our retaliatory capability is vulnerable. And the strategic air-power alternative to a dual capability would not avoid this drawback altogether by protecting our air power, for the associated greater protection of our cities would still, to a suspicious enemy, look as if we might launch a preventive war.

Some, of course, choose to avoid the hard issues of choice among military alternatives by simply advocating much higher defense budgets. Such budgets are economically feasible, but whether they are desirable or politically feasible is a different matter.

The responsible course is to face the

issues of choice by assuming budget constraints, seek reallocations that would get more at each budget level from the limited resources, and only then advocate higher total military budgets to the extent found desirable.

This procedure is particularly relevant because we may well be mixing inconsistent objectives in our programs. Certainly we can better use elsewhere the smattering of resources still spent in building a mobilization base for a remote World War II-like contingency.

Much more generally, we seem to have achieved an uneasy compromise between the dual capability and pure air-power alternatives outlined above—and we may be getting more of the disadvantages of each than their advantages. While we retain ready tactical forces and support those of our allies consistent with a dual capability strategy, we do so at such reduced levels that their ability to implement this strategy is gravely questioned.

Meanwhile we concentrate our air defenses around our cities as if in support of the rival strategy that seeks to make a strategic air-power threat credible in terms of deterring many kinds of aggression, but we cannot promise invulnerability to our people.

If defense budgets remain at current levels, perhaps we could get much better protection if we boldly try to realize the economies of a dual capability. If we concentrate more of our strategic air power in one well-defended force and economize upon our air defenses by concentrating them primarily upon the limited but indispensable function of protecting that force, we may free great resources for building tactical forces to fight truly limited wars.

With this posture we would not appear likely to initiate total war but would stand ready to punish terribly those who would, and we would possess more plentiful tactical means to counter local aggressions without invoking the supreme threat.

Of course, the reasonableness of adopting such a posture is dependent upon Soviet actions and our own choices. If the Reds should begin to disband their armies and put their cities underground, our fears of Soviet preemptive all-out attack would naturally rise, and we should probably be compelled to follow their risky and expensive course. Less obviously, the same result can follow because our own actions in "modernizing" our tactical forces with nuclear weapons go so far that the distinction between applying these forces and strategic nuclear bombing is lost upon the participants at the scene of conflict.

IN this case the provocation of the enemy is equally severe, our ally at the spot suffers as much and finds his own conventional forces equally as futile, and consequently the political advantages to us of having moderate and discriminating means of applying force are lost.

But if we act resolutely to maintain such means to counter local aggressions, which implies radical weapon limitation, we can without appeasement reduce the risk that a limited war will flame into a total war.

This course will involve large expenditures upon tactical arms. But this course alone gives our allies a real incentive to supply complementary conventional forces so they would assume part of the over-all burden, and it is more consistent with lower expenditures upon air defense at home than would be the case if we adopted the air-power alternative to a dual capability.

Far from being necessarily more expensive, such a dual capability may be the cheaper as well as militarily the more satisfactory course.

# For Scientific Education

## *A.O.A. inaugurates Crozier Fund for long-range armament preparedness*

THE American Ordnance Association has embarked upon a most significant step for the advancement of armament preparedness. The Crozier Fund for Scientific Education has been inaugurated by the Association's Board of Directors to assist in the training of scientists in basic and applied research.

It is the hope of the Association's governing board that the project will be most successful from the start and that the results of the studies undertaken will have important bearing on the progressive and scientific improvement of our American weapons. Thus, scientific education will be more thorough and the armament of our Army, Navy, and Air Force will be improved.

THROUGH the generosity of the late Maj. Gen. and Mrs. William Crozier, the American Ordnance Association is the recipient of a fund which may total more than $150,000. General Crozier, Chief of Ordnance of the Army from 1901 to 1918, was one of the founders of the Ordnance Association. He died November 10, 1942.

Under the will of Mrs. Crozier and in tribute to the memory of her distinguished husband, the Crozier residence at 1735 Massachusetts Avenue, Northwest, in Washington, D. C., was left to the Association. It was her wish that the property be used as national headquarters. Mrs. Crozier died August 2, 1955.

Since approval of the zoning authorities of the District of Columbia to use the property for national headquarters could not be obtained, the Board of Directors accepted an offer of the Brookings Institution of Washington, which has purchased the property.

From this and other bequests in the Crozier will, the Association will receive approximately $150,000 which will become the nucleus of the fund. Members of the Association already have contributed in varying amounts toward making the principal sum adequate to finance a number of fellowships regularly at accredited scientific institutions.

Such use of the Crozier benefaction will carry forward the intense interest of General and Mrs. Crozier in the work of the Ordnance Association and in the educational aspects of armament preparedness in the United States. In years to come, the site of Crozier House will be marked with an appropriate bronze plaque, and the fund will, of course, bear the Crozier name in its title.

The administration of the fund will be under a committee of qualified educators and industrialists who will assure efficient and effective use of it.

The timeliness of this action scarcely needs emphasis. Today the American people are keenly alive to the needs of the educational structure for adequate scientific training and the cultivation of disciplined interest on the part of students. Never before has the degree of popular concern been so general and so intense.

This is all to the good, for it confirms one of the basic tenets of the American Ordnance Association. Emphasis upon scientific preparedness has been one of the goals of the A.O.A. since its beginnings nearly forty years ago. It is encouraging, although belated, to have such general realization on the part of the American people of the soundness of this viewpoint.

The aim of the fund will be to assist our Army, Navy, and Air Force in obtaining adequately trained scientists for the investigation of special problems in both basic and applied science. Inasmuch as the services themselves are highly disciplined organizations, it is to be hoped that the scientific education which will result from the Crozier Fund will be as disciplined as it will be scientific. Thus the researches to be followed will not be of the casual, haphazard kind but rather those that are definitely attuned to our military needs.

IT is difficult to imagine a more worthy project to which members of the Ordnance fraternity could lend a sympathetic ear and material support than the goals of the Crozier Fund. At a time when scientific education is being nurtured from all sides—frequently in fields far removed from armament preparedness—it is especially fitting that individuals and companies consider the Crozier Fund as a proper object of their further benefactions.

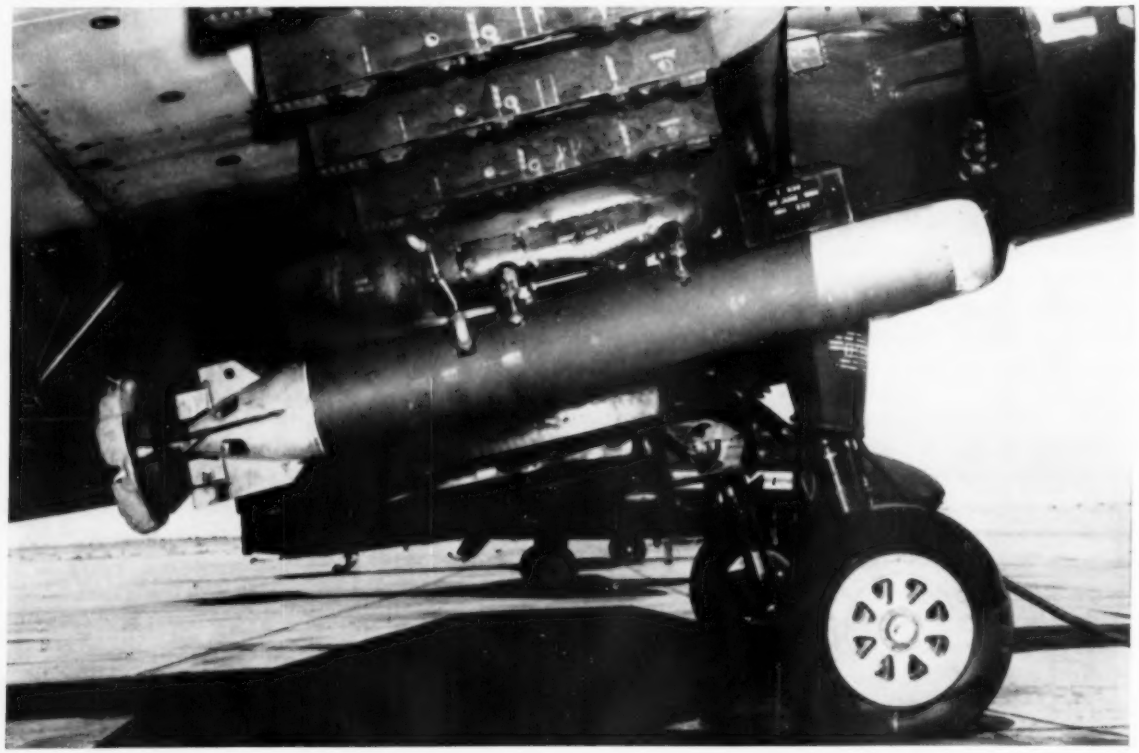
Armament preparedness in the United States is, to say the least, a spasmodic undertaking. Our people give it unstinted support in times of national concern; their interest diminishes the moment the emergency has passed. With such a project as that now being undertaken by the Ordnance Association, temporary interest and support would have no place.

Scientific education for armament preparedness is a continuing obligation, and the Ordnance Association will see to it in years to come that this obligation is met to the best of its ability.

A.O.A. members will be kept constantly informed in the pages of this journal of the progress of the undertaking. In the meantime, their counsel, guidance, and monetary support toward building the project to adequate proportions will be welcome.

# The New Torpedoes

The two new acoustic-homing torpedoes shown here are really submersible guided missiles and can search to great depths for enemy targets. The Mark 32 type, above, need not be fired from a tube but can be merely dropped overside from an open launcher. The lightweight Mark 42, below, is now operational with the fleet and can be launched from ships or aircraft (Navy photos).



# Defense Highlights: Monthly Review and Outlook

• **Defense Department reorganization** is under study and under fire from many angles. All four members of the Joint Chiefs of Staff in saying their piece several weeks ago generally favored the present setup as against centralizing power in one officer. All of them tactfully refrained from remarks about reorganizing the Department itself—they might be accused of frowning on civilian control. However, from congressional and other sources, excessive layers of Secretaries are under fire. One Congressman suggested that the three service Secretaries be abolished!

Now Defense Secretary Neil H. McElroy is being assisted in planning a reorganization by an advisory group he established composed of Gen. Nathan F. Twining, Chairman of the Joint Chiefs of Staff, and his predecessors, Adm. Arthur W. Radford and Gen. Omar N. Bradley. Also appointed are Nelson A. Rockefeller, chairman of the President's Advisory Committee on Government Organization; William C. Foster, a former Deputy Secretary of Defense; and Charles A. Coolidge, a former Assistant Secretary in the Defense Department who will serve full time as special assistant on the reorganization project.

Mr. Foster, as cochairman on the Gaither Committee, and Mr. Rockefeller, on his own committee, both recommended drastic changes in the Department of Defense. President Eisenhower has personally participated in preliminary discussions. A plan is to be ready for congressional action later this month.

• **Atomic Aircraft.**—Just as it appeared that Maj. Gen. D. J. Keirn, USAF, chief, Aircraft Reactors Branch of the Atomic Energy Commission, was prepared to fit the first available small atomic power plant into a large land-based aircraft, the Navy proposed that a seaplane be used instead.

Now the Navy is being unjustly accused of fomenting interservice rivalry by a sudden proposal to change the plan. Actually, Naval aëronautical engineers have been trying to get a top-level hearing for several years to present their thoughts on an atomic-powered seaplane.

• **The Military Budget.**—Mounting unhappiness is evident in the proposed military budget for fiscal 1959. Maj. Gen. B. J. Schriever, director of the Air Force Missile Development Center, has stated that he could give even greater impetus to the Thor and Atlas missile programs if more funds were authorized. The Navy reports a need for a more comprehensive antisubmarine warfare build-up, and the Army sees a weakening instead of an improvement in its strength and mobility.

The proposed budget is increased by only $1.5 billion, the smallest increase in several years. Many other weaknesses have been pointed out in the country's over-all strength by various military authorities. Their evidence has aroused the legislators to ensure that the armed forces' strength to fight a war next year is not being allowed to deteriorate while weapons are being developed for some far future date.

• **Mobility Needed.**—Lieut. Gen. James M. Gavin is gravely concerned with the lack of mobility for the Army's new Pentana divisions and the lack of research and development in fields other than missiles and satellites. He recommends an airborne shock force of seven or eight of the new streamlined Pentana divisions to combat limited aggression. After careful study of the great improvements in the quality of the armament of Communist troops, he is worried that our own equipment may become obsolescent through lack of research before it can be replaced with futuristic weapons.

• **Controls for Spacemen.**—While the Senate established a committee to prepare legislation for the control of outer-space developments, the Congress as a whole authorized the Secretary of Defense to administer nonmilitary space projects. The major issue in final legislation will be whether to establish military control of the program in the Defense Department or a civilian body such as the Atomic Energy Commission. On the Executive side, Dr. James R. Killian, Jr., the President's scientific adviser, is also making a special study on the sort of organization he recommends for directing all outer-space activities.

Hearings that led to the establishment of the Atomic Energy Commission went on for almost two years. Therefore Congress wisely has authorized the Secretary of Defense to administer temporarily all types of space projects, including military, that may be assigned. This authorization should help to bring order into the program of the Army, Air Force, and Navy for the exploration of outer space, providing the proposed regulatory body, the Advanced Research Project Agency, does not become overloaded and interfere at the working level.

• **Nuclear-powered Rockets.**—The Atomic Energy Commission recently revealed some of the results of its 3-year study of nuclear-powered rockets. Rear Adm. Lewis L. Strauss, Commission Chairman, said the AEC planned to expand research on both Project Rover, an atomic-powered rocket, and Project Pluto, an atomic ramjet rocket. He also revealed that the AEC has a reconnaissance satellite under study called Project Snap, similar to the Air Force's Pied Piper project.

• **Ordnance Chiefs Changed.**—The Army and Navy both are preparing to welcome new heads of their ordnance of-

fices. Lieut. Gen. Emerson L. Cummings, Chief of Army Ordnance, has already departed for new duty as Commanding General, United States Army, Japan, and Deputy Commanding General, Eighth U. S. Army. Maj. Gen. J. H. Hinrichs, the present Deputy Chief, is acting until a successor is appointed.

Rear Adm. Frederic S. Withington, Chief of the Navy Bureau of Ordnance, has been transferred to duty as Commander, Naval Forces, Japan. Admiral Withington will be succeeded by Rear Adm. P. D. Stroop, formerly Deputy Chief of the Bureau and recently commander, Taiwan Patrol Force.

• **Nike Hercules.**—Four of the country's vital centers will be protected by the Nike Hercules missile by June 1958. The Army announced that Washington-Baltimore, New York, Chicago, and Philadelphia would have the new, longer-range Nike missile operating alongside the older Nike Ajax in these areas.

• **New Missiles.**—Simultaneously with the announcement of the appointment of Roy W. Johnson, vice-president of General Electric Company, to direct the Advanced Research Projects Agency, the Defense Department gave a special briefing on the missile and satellite picture. The following rarely mentioned missiles were again brought to light: the Navy's Corvus, air-to-surface missile under production at Temco, Dallas, Tex., to be used for standoff bombing by carrier aircraft; also the Bull Goose, developed by Fairchild Aircraft Company, and the Green Quail, McDonnell Aircraft Company—air-to-air and air-to-surface diversionary missiles. The latter two are Air Force weapons planned to confuse enemy radar, hiding the location of the "pay-off" missile in an attack. Likewise recently described was the Navy's rocket-assisted torpedo (Rat) which is fired through the air from shipboard by rocket, descends by parachute, and then homes on enemy submarines.

• **Man-made Weather** is demanding concentrated study. Dr. H. G. Houghton, director of the Laboratory of Earth Scientists at the Massachusetts Institute of Technology, has reported several ways by which man could alter the weather of large earth areas. He and several other eminent scientists in the field have pointed to the growing possibilities of this tactic being used by enemy powers to cause more damage than massive nuclear attacks. They seek further concentrated study and vast experimentations for the security of the United States.

• **Research and Development.**—Dr. James R. Killian lists the following grand strategy to maintain our relative strength in technology that he claims now leads the world: long-range objectives with a better balance between basic research and development; more continuity of effort with fewer stops and starts in the support of research; "a sustained effort to modernize and invigorate scientific education"; and more attention to the cultivation of talent and quality in intellectual accomplishment.

Through the efforts of Dr. Killian and others, the U. S. Commerce Department is establishing a central clearing house to translate and distribute Soviet scientific reports. The National Science Foundation will speed up the translation of such documents. Compared with other nations, the translation of Soviet and other countries' research papers is notoriously behind schedule in the United States.

• **Space Vehicle.**—The Air Force X-15 rocket aircraft approaches so close to outer-space capability that AF researchers might worry over losing jurisdiction to the ARPA. However, this program stems from the early Bell X-1 and X-2 research craft, the test beds for the Century Series. With the X-15, the Air Force hopes to fly at speeds of over 3,600 miles an hour and possibly climb to 400 miles. The program is a joint endeavor of the National Advisory Committee for Aëronautics, the Air Force, the Navy, and industry. North American Aviation, Inc., is building the structures, and the rocket motor will come from Reaction Motors, Inc. The top problem appears to be returning the craft to the heavy atmosphere without burning up the pilot.

• **Antisubmarine Warfare.**—The principal need of the fleet, according to Adm. Jerauld Wright, Commander in Chief of the Atlantic Fleet and NATO forces in the Atlantic, is more research and development activity in antisubmarine warfare. This problem calls for improved detection equipment, aircraft, and helicopters. Complicating naval defense considerations is the capability of all Communist naval craft to lay massive minefields of many types, a great hindrance to both surface ships and submarines.

• **Antimissiles.**—In addition to its antimissile missile, Nike Zeus, designed to counter ICBM's, the Army has disclosed interest in an antimissile to protect troops in the field against enemy missiles. Though these projects remain highly classified, Maj. Gen. Robert J. Wood, Deputy Chief of Army Research and Development, said that excellent progress was being made with both types.

• *Gen. Thomas D. White, Chief of Staff, United States Air Force, was presented recently with a check for $2562.98 for the Air Force Aid Society at a brief ceremony in the Headquarters of the United States Air Force, Washington D. C. The check, which was turned over by Maj. Gen. E. P. Mechling, of the A.O.A. headquarters staff, represented the excess of receipts over expenditures from the annual Industrial Preparedness Meeting of the Association at the Waldorf-Astoria, New York, December 4, 1957. This is in accordance with the long-standing policy of the Association of donating such funds to a service charity.*

# Our Level of Defense

## An Editorial

THE clubs are so full of opinions about the status of our national defense these days that probably the best thing sensible people can do is to hope and pray that the most competent professional judgment will prevail. As far as the reorganization of the Defense Department is concerned, there seem to be as many points of view as there are viewers. Heartening aspects of the problem are that something *will* be done to improve the situation.

The consultants now advising the Secretary of Defense are capable and experienced authorities. They include General of the Army Omar N. Bradley, former Chairman of the Joint Chiefs of Staff; William C. Foster, former Deputy Secretary of Defense; Adm. Arthur W. Radford, another former Chairman of the Joint Chiefs; Gen. Nathan F. Twining, the present Chairman; and a former Assistant Secretary of Defense, Charles A. Coolidge. Nelson Rockefeller who had a hand in reorganizing the Defense Department five years ago also will be aboard to see at first hand the lengths to which the empire builders have distorted the original doctrines of Mr. Forrestal. On this side of the problem all seem to agree that changes are in order and that that they will be for the best.

Red tape must go. Efficiency and economy are the watchwords. The observer would be well advised to engage in deep and heartfelt prayer that the results will ultimately prove the remedies effective and that the Nation can get on to the important work at hand: More and better national defense at less waste of time and money.

AND that brings us to the main point; namely, the crying need for a long-range national policy on the level of our defense. For too many years the level has been prominent because of its unsteadiness. Our military operations have been on a feast-or-famine basis. One year we go all out, the next years the brakes are on and we cut back. Right now we are again on the upgrade just after cutting back drastically—another crash program is under way. Indeed, with us the national attitude toward our level of defense over the long term is either one of hysteria or of complacency.

The cost of this folly is tragic both in lives and money. It is time we set our sights and hold the level for a definite period, if for no other reason than to save our substance.

An excellent paraphrase of this condition was contained in an address recently before the San Francisco Post of the Ordnance Association by E. Finley Carter, director of the Stanford Research Institute. Mr Carter said:

"We were given a warning with the first Russian satellite. That warning has been reëchoed by the second satellite. We Americans have, to date, reacted just about as might have been predicted. We have criticized the incumbent Administration, the armed services, and our scientists; we have demanded investigations; and we have sought to pass the buck.

"Now, fortunately, our awareness of the need for constructive action appears to be manifesting itself in a more active public interest in the direction of our over-all research and development effort. This has reached a point where some appear to be willing even to make personal sacrifices in order to achieve our goals.

"Perhaps we are in a better position than ever before to move forward. The satellites have jarred us out of complacency. They have created a national consciousness of the need for greater and more effective scientific research to maintain our posture of military strength while seeking more effective means of creating permanent peace through mutual understanding.

"Let us learn from our mistakes—not die by them. Let us grasp this opportunity and proceed with the job ahead."

THE present outlook for our Army is decidedly down, according to the President's budget. There will be a 7 per cent reduction in manpower—from the present 936,000 to 870,000. The number of divisions will be reduced from 15 to 14; the number of guided missile battalions will be increased from 62 to 73. The appropriations will be reduced from $9.04 billion to $8.88 billion.

The Navy and Marine Corps will have a general increase of 3 per cent in appropriations from $10.64 billion to $10.91 billion. While manpower will be reduced 3 per cent (832,000 to 805,000) and warships reduced by 13 (409 to 396), the all-important category of nuclear submarines will be increased by 3. By mid-1959 we should have our total of these essential weapons increased from 3 to 6.

Our Air Force will be reduced in manpower from 890,000 to 850,000. The number of wings will be reduced from 130 to 105. The available aircraft will be cut from 20,600 to 19,142. Guided missile units will be increased from 1 to 5.

The over-all effect will reduce total active manpower by 5 per cent (2,658,000 to 2,525,000) while total expenditures will be increased 3 per cent ($38.8 billion to $39.8 billion). The most noteworthy effect will be greater programs for missiles, nuclear submarines, and other new weapons. All this is subject to review and probable change upward.

The point many competent observers make is this: The condition of our international relations is such that we are warranted in establishing a firm program over a relatively long period and once having determined that level to hold to it regardless of headlines of the moment.

# ASSOCIATION AFFAIRS

## *Maj. Gen. E. P. Mechling Retires, Joins A.O.A. Headquarters Staff*

Maj. Gen. Edward P. Mechling, Commander, Air Force Armament Center, Eglin Air Force Base, Fla., retired from active military duty January 4, 1958. He is now a member of the headquarters staff of the Ordnance Association in Washington, D. C., where, in conjunction with Brig. Gen. Burton O. Lewis, he will assist in the planning and operations of the Association's Technical Divisions and Committees which now number more than one hundred.

General Mechling is a native of Washington, D. C. He was graduated from the United States Military Academy at West Point in the Class of 1927.

The occasion of his retirement was observed at Eglin by a series of fetes and a military review in honor of his long and outstanding leadership in the field of armament, and especially in the advancement of air armament research.

General Mechling was awarded the Distinguished Service Medal by the Air Force and the Scott Gold Medal by the Ordnance Association.

There were a series of celebrations including a reception by the Fort Walton Beach Chamber of Commerce, a dinner-dance by the noncommissioned officers, and a reception and dance at the Officers' Club by the officers and civilians of the Armament Center. At the latter, on the evening of January 3rd General and Mrs. Mechling received the guests in an especially decorated hall where a large contingent of Air Force personnel, members of the Ordnance Association, and representatives of science and industry were in attendance.

At the military review in his honor on January 4th, General Mechling was presented the Distinguished Service Medal by Maj. Gen. John W. Sessums, Vice Commander, Air Research and Development Command, on behalf of the Secretary of the Air Force. The citation which accompanied the award reads:

"Maj. Gen. Edward P. Mechling distinguished himself by exceptionally meritorious service to the United States in a position of great responsibility as Commander, Air Force Armament Center, Eglin Air Force Base, Fla., from 4 February 1952 to 30 November 1957.

"Throughout this time, General Mechling improved the character of the Air Force air armament testing immeasurably and with it has effected significant improvements in the armament capability of many of our current air weapon systems. This has been accomplished despite incomplete and inadequate facilities and scant resources.

"General Mechling's achievements in the field of air armament, and his outstanding leadership, organizational ability, and professional knowledge have resulted in vitally significant contributions to the security of the United States. The singularly distinctive accomplishments of General Mechling culminate a long and distinguished career in the service of his country and reflect great credit upon himself and the United States Air Force."

Following the review, General and Mrs. Mechling were guests of honor at a luncheon tendered by the Florida Post of the Ordnance Association of which General Mechling is a charter member and former president. Among the honor guests was Maj. Gen. Robert W. Burns, Commander, Air Proving Ground Center, ARDC, Eglin Air Force Base. Greetings were extended on behalf of the Air Force by General Sessums. An attractively bound volume of letters from friends and associates was presented to the general by Col. Jack Sun, and a shotgun was presented by Col. Jan Laitus on behalf of the members of the Florida Post.

The award of the Scott Medal to General Mechling was made by Louis Polk, vice-president of the Association, and the presentation was made by Col. Henry N. Marsh, general chairman of the Association's Technical Divisions and Committees. Greetings were extended on behalf of the Association by Col. Leo A. Codd, executive vice-president. Col. Eugene A. Romig, president of the Florida Post, presided. The citation which accompanied the Scott Medal award reads:

"Throughout his long service to armament progress, General Mechling has typified the best traditions of the military profession. Graduate of the United States Military Academy, the Ordnance School, and the Massachusetts Institute of Technology, he was well equipped to undertake the development of weapons, first for the Army and subsequently for the Air Force. His service with the Army spanned the crucial years prior to and during the Second World War. Following that conflict he was transferred to the Air Force and since has taken a leading part in the development and test of superior weapons systems for the Air Force as Commander of the Air Force Armament Center.

"His outstanding talents as engineer, technician, and administrator combined with his broad experience have contributed in great measure to the high standards of the armament of the United States Air Force.

"The American Ordnance Association confers upon General Mechling, a member of its national Council and a leader in its Florida Post, its gold medal named in honor of Frank A. Scott, a founder of the Association and chairman of the General Munitions Board in the First World War."

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### George Fielding Eliot Addresses Meeting Of The Association's Aberdeen Post

The Aberdeen Post of the Association held its fall dinner meeting at the Recreation Center, Aberdeen Proving Ground, Md., on November 19th. There was an excellent turnout of almost 200 members who had assembled to greet George Fielding Eliot, the guest speaker.

**George Fielding Eliot, left, accepts a model rocket and launcher from Harry A. Bechtol, president of the Aberdeen Post.**

Prior to introducing Mr. Eliot, Harry A. Bechtol, Post president and presiding officer at the dinner, presented a certificate of appreciation to Edward B. Cummins, past president of the Post, awarded by the national Board of Directors for his devoted service.

Mr. Eliot, an internationally known military analyst, discussed in a most interesting and understandable manner the complexities that face our Defense Department in planning on a worldwide basis. He made note of the many areas in which we must be prepared to protect our interests or those of our allies throughout the world in order to do our part as a leading power.

At the conclusion of his talk, as a measure of esteem from the membership of the Post, Mr. Eliot was presented with a model of an Honest John artillery rocket and launcher.

## *A.O.A. Board of Directors Conducts Regular Annual Meeting in New York*

The regular annual meeting of the Board of Directors of the Association held at the University Club, New York City, on December 3, 1957, was noteworthy for the great numbers that were able to attend. Members of the Board present were: Benjamin W. Chidlaw, A.O.A. president, presiding; Harvey C. Knowles, vice-president; Louis Polk, vice-president; Robert L. Biggers, vice-president; Stanley C. Hope, vice-president; John S. Pfeil, Omar N. Bradley, William W. Coleman, Frederick H. Payne, Levin H. Campbell, Jr., Paul L. Davies, William K. Fitch, Herbert A. Gidney, George F. Hussey, Jr., Henry N. Marsh, Erle Martin, R. L. Maxwell, and Lysle A. Wood, directors.

The following officers of the Association also were present: John Ross Delafield, counsel; Wellwood E. Beall, regional vice-president; C. L. Eksergian, regional vice-president; Helge Holst, regional vice-president; Daniel J. Martin, regional vice-president; Leo A. Codd, executive vice-president; and Florence G. Ferriter, secretary.

From the staff of national headquarters were: Burton O. Lewis, Roger E. Lewis, J. M. P. Wright, and Robert J. Warfel. In addition, by invitation of the Board, the following members of the Advisory Board were present: E. R. Godfrey, A. W. Herrington, and K. T. Keller.

The meeting was called to order by the president who welcomed the members to the thirty-ninth annual meeting of the Board, especially the following members of the Board who were attending their first meeting: Maj. Gen. R. L. Maxwell, New York, N. Y.; Paul L. Davies, San Jose, Calif.; Erle Martin, Windsor Locks, Conn.; and Lysle A. Wood, Seattle, Wash. The Board has met at least once a year since the foundation of the Association, October 3, 1919.

A review and analysis of the operations of the Association were presented by members of the national headquarters staff in the form of five reports. The treasurer's report disclosed that for the period January 1 to October 31, 1957, total receipts from all sources were $468,507.03 and total expenditures for all purposes were $438,502.14. The Association has no financial obligations or indebtedness of any kind other than current day-to-day commitments.

The membership report showed a net gain thus far this year of 714 members. There are also 2,180 paid subscribers (nonmembers) for ORDNANCE, the Association's bimonthly journal. It was also noted that many of the Posts are very active in building A.O.A. membership.

The publications report noted that ORDNANCE, the bimonthly journal of the Association, has been published continuously since 1920. The average press run was nearly 46,000 copies in 1957. During the past year, major articles by eighty-four well-qualified authors have appeared in its pages, making it an excellent forum for discussion of topics vitally connected with our national defense.

With the September-October 1957 issue, ORDNANCE inaugurated a feature that has met with wide acclaim; namely, a pictorial report in the form of a large folded insert on various types of American armament. Reprints of these inserts have been in heavy demand.

THE COMMON DEFENSE, the monthly Washington newsletter of the Association, had an average monthly press run of 41,000 copies. INDUSTRIAL PREPAREDNESS, reporting on the Association's national Technical Divisions and Committees, had an average press run of 3,000 copies. An issue of LOGISTICS, "New Technological Developments in American Armament," was published in May. Eighty-five hundred copies were printed for distribution to Association officials, company members, and members of the Technical Divisions and Committees.

Technical Divisions were reported to have enjoyed unusual activity and well-attended meetings. All major Divisions and Committees held their annual meetings, predominantly classified and often called at the request of the armed services.

Local Posts were reported to have been most active. Meetings were addressed by outstanding representatives of the Army, Navy, and Air Force, as well as by leading figures in science and industry. Full accounts of Post meetings were published in the Association Affairs department of ORDNANCE.

The most important order of business was the consideration of plans for the use of Crozier House. The executive vice-president reviewed briefly the background of the gift of Crozier House to the Association and the previously approved plans to use the property as national headquarters. He outlined the continuing difficulties in zoning restrictions for remodeling the property and then read the offer of the Brookings Institution for the purchase of the Crozier property to be used in connection with the Brookings development. After lengthy discussion, a resolution was unanimously adopted to accept the offer of the Brookings Institution, and it was resolved that this sum, together with all other funds received from the Crozier estate, be invested in suitable securities, the income therefrom to be used to establish one or more fellowships in the sciences at major universities, the fellowships to be known as the Crozier Fellowships.

A proposed budget of income and expenditures for the year 1958 was presented in detail by the executive vice-president and was unanimously approved as submitted.

A draft of a proposed statement of objectives of the Association for 1958 was presented. After lengthy discussion, it was decided to reword certain subjects mentioned in the draft and submit the redraft to members of the Board for approval at a later date.

There being no further business, the meeting adjourned in order that all present might attend the Council luncheon.

At the Council luncheon, General Chidlaw turned the meeting over to Colonel Coleman, Council chairman, who expressed his pleasure over being present and called on Helge Holst, a regional vice-president, to present results of the balloting for new directors and twenty-four members of Council at large.

The following directors, whose terms had expired, were reëlected: Mr. Biggers, Chrysler Motors Corporation, Detroit, Mich., and Mr. Polk, Sheffield Corporation, subsidiary of Bendix Aviation Corporation, Dayton, Ohio. New directors were: Albert W. Gilmer of Barnes, Dechert, Price, Myers & Rhodes, Phila-

delphia, Pa.; Dan A. Kimball, Aerojet-General Corporation, Azusa, Calif; and Henry T. Luria, Luria Steel & Trading Corporation, New York, N. Y. Directors elected for life were: Colonel Gidney, Fort Lauderdale, Fla.; and Mr. Knowles, Procter & Gamble Company, Cincinnati, Ohio.

The twenty-four members of Council at large are: Joseph L. Auer, R. Hoe & Company, New York, N. Y.; John S. Begley, attorney at law, Holyoke, Mass.; Harold R. Boyer, Cadillac Tank Plant, GMC, Cleveland, Ohio; Whitley C. Collins, Northrop Aircraft Company, Hawthorne, Calif.; Jacob L. Devers, Fairchild Engine and Airplane Corporation, Alexandria, Va.; Irving A. Duffy, Ford Motor Company, Detroit, Mich.; E. B. English, Caterpillar Tractor Company, Peoria, Ill.; Maurice A. Fraher, Deere & Company, Moline, Ill.; Robert C. Geffs, Clary Corporation, San Gabriel, Calif.; Britton L. Gordon, Blackmer Pump Company, Grand Rapids, Mich.; W. Arnold Hanger, Mason & Hanger-Silas Mason Company, New York, N. Y.; Carl R. Hellstrom, Smith & Wesson, Inc., Springfield, Mass.; Carl G. Holschuh, Sperry Gyroscope Company, New York, N. Y.; Walter N. Howley, Lansdowne Steel & Iron Company, Morton, Pa.; Roy T. Hurley, Curtiss-Wright Corporation, Wood-Ridge, N. J.; Ernest G. Jones, Skagit Steel & Iron Works, Sedro-Woolley, Wash.; J. Kirby McDonough, Murray Company of Texas, Dallas, Tex.; John C. McHaman, Central National Bank, Cleveland, Ohio; Thomas E. Murray, Sr., Murray Manufacturing Corporation, New York, N. Y.; Walter C. Pew, Sun Oil Company, Philadelphia, Pa.; M. F. Schoeffel, General Precision Equipment Corporation, Washington, D. C.; Henry J. Sullivan, Detroit Edison Company, Detroit, Mich.; William W. Spruance, Wilmington, Del.; and J. Carlton Ward, Jr., Vitro Corporation of America, New York, N. Y.

General Chidlaw introduced Rear Adm. R. E. Rose, Assistant Chief of Naval Operations for Fleet Operations and Readiness, who gave an excellent talk on the status of our naval forces and the expected future trends in naval armament.

Assistant Secretary of the Army for Logistics Frank Higgins followed with a discussion of the introduction of a fourth or logistic service into the Department of Defense and the probability that it would further encumber the already monstrous Department of Defense maze. Admiral Rose's address is published in full on page 793 of this issue.

## *Record Turnout Honors General Twining At Annual Dinner of Cleveland Post*

The annual dinner meeting of the Cleveland Post, held this year in honor of Gen. Nathan F. Twining, Chairman of the Joint Chiefs of Staff, at the Hotel Carter, Cleveland, Ohio, on Tuesday, November 12th, had a record attendance of over 600 members.

Toastmaster Albert J. Weatherhead, Jr., Post president, after introducing the distinguished guests, called on Gen. B. W. Chidlaw, national president of the A.O.A., to brief the members on Association programs. General Chidlaw described plans for the annual meeting, outlined the objectives for the coming year, and emphasized how the Association was playing a key rôle in today's changing national-defense picture.

**C. M. White, left, Cleveland Post president, presents Crowell Medal to Gen. N. F. Twining, Chairman, Joint Chiefs of Staff, as Post Vice-president J. E. Trainer, President A. J. Weatherhead, Jr., and Gen. B. F. Chidlaw, national president, look on.**

The Hon. Anthony Celebrezze, Mayor of Cleveland, welcomed the guest of honor and the members on behalf of the city and offered the backing of Cleveland in support of a strong national defense.

After an introduction by the presiding officer, General Twining was presented with the Association's Benedict Crowell Gold Medal for distinguished service in the cause of peace and defense. This ceremony was conducted by Charles M. White, a director of the Cleveland Post and chairman of the board of Republic Steel Corporation. Mr. White noted that the Crowell Medal was founded in honor of Brig. Gen. Benedict Crowell, who served as Assistant Secretary of War and Director of Munitions in the First World War and for twenty years as president of the A.O.A.

General Twining, in his address, outlined briefly the nature of the Communist forces arrayed against the free world and called for strong support of military aid programs to strengthen our own allies. He spoke out for alert and farsighted planning with proper consideration for technological developments and the importance of trained manpower.

The general especially stressed that, "in order to have the necessary quality and combat effectiveness, means must be found to encourage more of our trained people to make careers of military service."

## Dixie Post of Association Inaugurated at Hampton, Va., On Pearl Harbor Day, 1957

The Dixie Post was inaugurated in the best traditions of the American Ordnance Association at a gala meeting at the Chateau Restaurant, Hampton, Va., on Saturday, December 7th. The date was chosen in commemoration of Pearl Harbor Day since the group that established the Yorktown Chapter, forerunner of this Post, included many men with naval backgrounds.

Preceding the meeting, a reception was held for the honor guests, Brig. Gen. Homer A. Boushey, Deputy Director of Research and Development, U.S.A.F., and Mrs. Boushey. The dinner meeting was opened with an invocation delivered by the Rev. J. O. Schmidhauser, pastor, St. Mary's Star of the Sea Church, Fort Monroe, Va. Post President George Svadeba gave a brief welcome and presented General Boushey with an honorary membership in the Association.

Trist B. McConnell then took over the meeting as toastmaster and introduced Capt. J. M. P. Wright from national head-

quarters who presented the charter to this Thirty-eighth Post of the A.O.A. on behalf of Gen. B. W. Chidlaw, A.O.A. president, and the national directors of the Association.

Mr. McConnell surprised the assembly by appearing as Gen. Robert E. Lee, and upon his signal the Confederate flag was hoisted to the tune of "Dixie."

General Boushey delivered a splendid address on the activities of the Air Force Research and Development Command. He pointed out that to overcome Communist superiority in numbers and quantity of material, the Western world must maintain technical superiority. Before elaborating on the fascinating developments being undertaken at the twelve different activities of ARDC, the general outlined its objectives: to ensure that a basic research program will furnish adequate fundamental information, to provide improvement for existing weapons systems, and to develop new weapons systems of superior capability outstanding effectiveness.

General Boushey emphasized that modest expenditure for basic research now will be an investment in future national security. He stressed the need for urgency and concluded by stating that in the United States our race for space may be our race for survival.

The new Dixie Post area includes North and South Carolina, which formerly had no Post headquarters, and southern Virginia. Members decided that the Yorktown Chapter officers and directors would carry on in the same capacity for the new Post and that additional officers and directors would be added as they became acquainted with the members in the Carolinas and other sections of southern Virginia.

## *A.O.A. Fire Control Committee Holds Meeting at Naval Submarine Base*

The fall meeting of the A.O.A. Fire Control Committee, Underwater Ordnance Division, was held at the U. S. Naval Submarine Base, New London, Conn., November 19-20, 1957. Alton D. Anderson, Committee chairman, from the Cook Research Laboratories, Chicago, Ill., opened the first day's session at 9:30 a.m. and presided throughout the meeting. He was assisted by Deputy Chairman Richard Y. Miner, Arma Division, American Bosch Arma Corporation, Garden City, N. Y., and Committee Secretary Roy C. Schoenhaar, Ford Instrument Company, Division of Sperry Rand Corporation, Long Island City, N. Y.

After the opening preliminaries, including a gracious welcome by the station commander, Chairman Anderson called on the representatives of the Navy Bureau of Ordnance for a panel discussion on current underwater ordnance fire-control problems. This discussion stressed that the basis of problems presented should be very specific and not as broad as has been customary in the past. It was pointed out that an initial requirement—sometimes called military characteristic—is really a matter of technical capabilities with operational limitations.

The size and complexity of current fire-control tasks require the best combined efforts of industry and the military. Supervision must be exercised during the progress of a development to ensure solution of the specific problem without being so restrictive as actually to curtail its maximum successful accomplishment. While problem requirements must be firm, they must at the same time facilitate the optimum solution.

This interesting discussion continued until 11 a.m. at which time Mr. Anderson adjourned the general meeting. The balance of the morning until 12:30 p.m. was devoted to individual subcommittee meetings.

After luncheon at the Officers' Club, an excellent tour of the Submarine School was embarked on with running operations of the Mark 101 fire-control system and demonstrations of two sub trainers. Capt. W. W. McCrory, heads the Submarine School.

During the evening, a reception and dinner was enjoyed at the Lighthouse Inn. Adm. James R. Fife, Jr., formerly Commander, Submarines, Atlantic Fleet, was the principal speaker.

Chairman Anderson opened the second day's session at 9 a.m., calling on Captain Lynch and Commander Catlin to inaugurate the discussion on bottlenecks that presently exist in the successful prosecution of undersea warfare. This discussion developed a number of specific problems and disclosed the progress being made in their ultimate solution.

Most of the second day was devoted to classified discussions with talks by Frank Lynch, Electric Boat Company, Division of General Dynamics Corporation, Groton, Conn.; Lieut. Comdr. W. R. Cobean, executive officer of the NAUTILUS; Comdr. R. F. Dobbins, and Lieut. P. J. Early.

During the course of the day, operating agendas for the three subcommittees were reviewed and approved.

This meeting was most successful in briefing the A.O.A. Committee on current underwater fire-control problems and was adjourned with a vote of sincere thanks to the Navy for genuine hospitality and splendid cooperation.

Members of the A.O.A. Fire Control Committee attending this meeting were: Messrs. Anderson, Miner, and Schoenhaar; William Divan, Ford Instrument Company, Long Island City, N. Y.; A. C. Clemenson, Arma Division, American Bosch Arma Corporation, Garden City, N. Y.; Wayne G. Shaffer, Vitro Laboratories, Silver Spring, Md.; Thomas D. Bryant, Librascope, Inc., Glendale, Calif.; Oscar Lorentzen and Melvin W. Arsove, Raytheon Manufacturing Company, Wayland, Mass.; John Ryan, Daystrom Instrument Corporation, Woodside, N. Y.; George Robertson, General Electric Company, Pittsfield, Mass.; Dr. Otto Weil and Paul Cohen, Sperry Gyroscope Company, Great Neck, N. Y.; L. E. Benitez, Crosley Division, Avco Manufacturing Corporation, Cincinnati, Ohio; John Litsios, W. L. Maxson Corporation, New York, N. Y.; D. M. Sherwood and J. M. Rummell, Pacific Division, Bendix Aviation Corporation, North Hollywood, Calif.; and G. H. DeWitz, Hoffman Laboratories, Inc., Los Angeles, Calif.

Attending in an advisory capacity were: Benton Hall Schaub, from the Office of the Assistant Secretary of Defense (Research and Engineering); Capt. C. B. Stevens, Comdr. Perry Hall, Lieut. Comdr. J. Grace, Paul W. Burk, John S. Kenyon, and S. J. Solt from the Navy Bureau of Ordnance; and Adm. W. W. Juvenal from Lytle Engineering & Manufacturing Company, Albuquerque, N. Mex.

### E. Finley Carter Addresses Luncheon Meeting of the San Francisco A.O.A. Post

The San Francisco Post held a most outstanding luncheon meeting on Thursday, December 5th, at the Fairmont Hotel, San Francisco. William E. Butts, retiring Post president, was presiding officer and, as a parting recommendation, urged the members to concentrate as a special project on the inventions needed by the armed forces. He pointed out that there were some 380 urgently needed inventions compiled in a recent Department of Commerce bulletin and commended their study to all members of the Association in order to advance America's national defense.

The guest speaker was E. Finley Carter, director of Stanford Research Institute and newly elected vice-president of the San Francisco Post. In keeping with Mr. Butts' appeal for more progress in developments that will help our defense, Mr. Carter stated that this Nation must improve its ability to respond quickly to any new developments and shorten the lead time from research to operational systems. "We never again can afford the complacent conceit that Soviet scientists are less competent than our own," he said.

Mr. Carter advocated more emphasis on improving our storehouse of scientific information and broader exchange of scientific data with other nations. He greeted the Communist satellite achievement with pleasure as he felt that, after much criticism, the American people finally have realized that the Nation as a whole was to blame for our deficiencies in this field and are at last prepared to take action.

Distinguished guests at the head table included: Dean Witter, regional vice-president, A.O.A.; Maj. Gen. J. J. Binns, chief of staff, Sixth United States Army; W. E. Waste, new Post president; Rear Adm. W. L. Erdmann, deputy commander, Western Sea Frontier; and L. S. Fletcher, national Council representative.

**William E. Butts, left, retiring Post president, and W. E. Waste, new executive.**

reported that, with the advent of Polaris, the Navy would be well equipped with missiles of every category. He explained that although these missiles were adequate for the present state of the art they were merely the forerunners of more sophisticated weapons yet to come.

## *Philadelphia Post Visits Planetarium, Hears Admiral Raborn at Dinner Meeting*

The Philadelphia Post held an afternoon and evening of A.O.A. activity on Tuesday, November 19th. The program opened with a visit and lecture in the Fels Planetarium of the Franklin Institute where Dr. I. M. Levitt, planetarium director, presented an intensely interesting discussion of the satellite program of the United States in this International Geophysical Year, amplified with tracing satellite paths in the heavens of the planetarium.

After a brief break, the crowd was swelled by the latecomers who arrived in time for the reception and the dinner meeting held in the dining hall of the Franklin Institute. Everett Webster, president of the Post, presided at the meeting and introduced the following distinguished guests: Dr. J. S. Burlew, executive vice-president, Franklin Institute; C. L. Eksergian, chairman, A.O.A. Guided Missile and Rocket Division; Capt. James M. Farrin, commander, Philadelphia Naval Shipyard; Dr. Levitt; Rear Adm. S. B. Spangler, commanding officer, Naval Air Development and Material Center, Johnsville, Pa.; and Col. H. C. Thayer, commanding officer, Philadelphia Ordnance District.

Following a brief report on Post affairs, Mr. Webster introduced Rear Adm. W. F. Raborn, Director of Special Projects, Navy Bureau of Ordnance, the guest speaker.

Admiral Raborn, who is responsible for the entire Polaris weapons system program, including surface ship and submersible launching craft, briefly alluded to this highly classified defense project and related the general aspects of the Navy's guided missile program. The admiral

**Attending Philadelphia Post meeting were, left to right: Rear Adm. S. B. Spangler, U.S.N., Johnsville, Pa.; E. B. Webster, Post president; Rear Adm. W. F. Raborn, Jr., guest speaker; Dr. I. M. Levitt, Fels Planetarium; C. L. Eksergian, Budd Company; Capt. J. M. Farrin, U.S.N., Philadelphia, Pa.; Col. H. C. Thayer, U.S.A., Philadelphia.**

## Michigan Post Confers Dow Medal Upon General Gavin At Meeting in Detroit

The Michigan Post held its annual dinner meeting on Tuesday, December 10th, in the grand ballroom of the Sheraton-Cadillac Hotel, Detroit, Mich. The atmosphere of this affair was charged with an undercurrent of excitement over the outstanding character of the guest speaker and the founding of a new A.O.A. medal. A glow of pride was evident over the past year's excellent growth in membership which included both individual and company members.

The meeting was a great tribute to Del Harder, a greatly admired and respected leader in Detroit, who presided as Post president. Mr. Harder has devoted much of his time to advancing the aims of the Association. His leadership and personal interest in the Michigan Post were the big factors behind the enthusiasm of the record attendance of 752 that packed the ballroom.

After a reception for Lieut. Gen. James M. Gavin, Chief of Army Research and Development, guest of honor, the meeting opened promptly with the National Anthem, followed by an invocation by Dr. John A. Visser, minister of Westminster Church.

The assemblage was welcomed by the toastmaster, William A. Mayberry, Manufacturers National Bank, a member of the Post's Advisory Committee. The newly elected directors were announced, and they, together with the president-elect for 1958, Louis E. Moultane, president of McClouth Steel Corporation, received a round of applause. The six new directors will be: John Dykstra, Ford Motor Company; J. Thomas Smith, Detroit Harvester Company; Neil C. McMath, Whitehead & Kales Company; E. Howard Perkins, Brooks & Perkins, Inc.; Arthur W. Wild, Continental Aviation & Engineering Company.; and Irving J. Minett, Chrysler Corporation.

Post President Harder reviewed the achievements for the year 1957, including the great work of the Membership Committee, praised the aims of the Association, and acclaimed the hearty coöperation he received as president. His remarks were climaxed with a standing ovation. *(Continued on p. 836)*

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## Cincinnati Hydrospin

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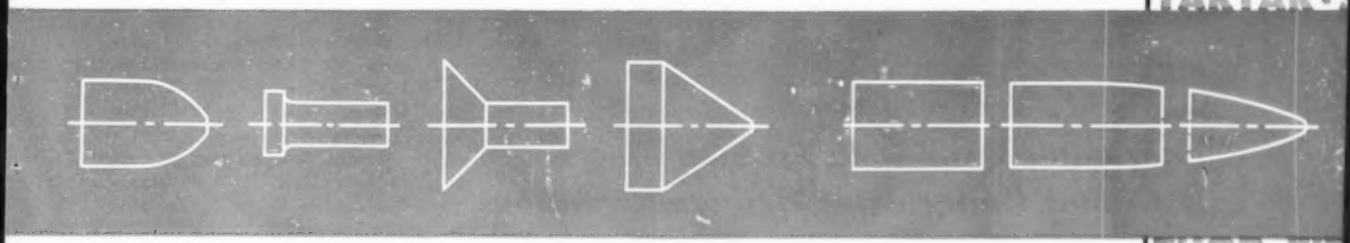

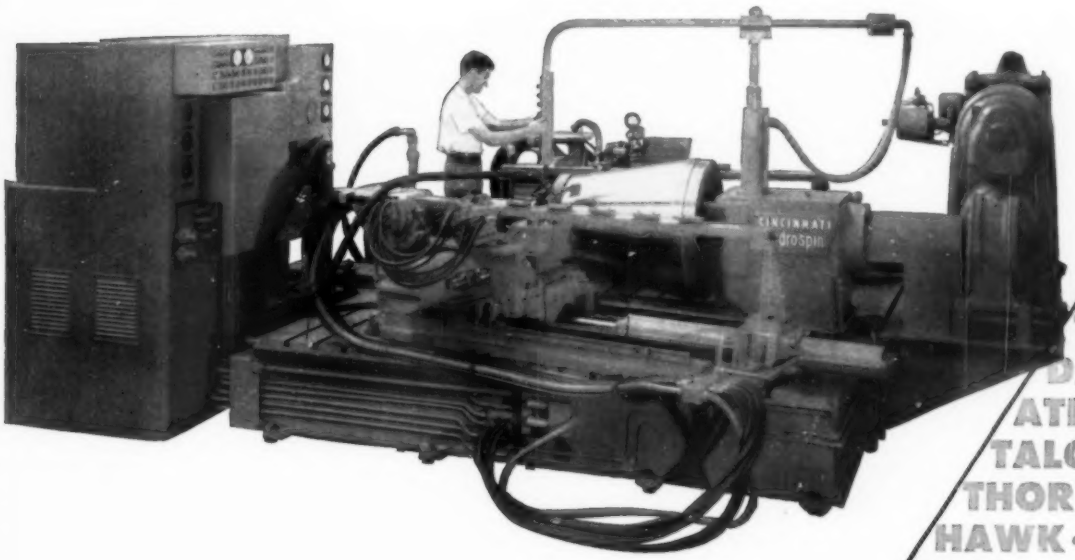


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Special tribute was paid to Mervyn Gaskin, chairman of the Membership Committee, F. Russell Valpey, vice-chairman, and the members of the Red and Blue membership teams. The Red team consisted of: D. C. Pippel, Ford Motor Company, captain; Leslie G. Taylor of the Kelsey-Hayes Company; John Wilt, Manufacturers National Bank; Frank Churley, Federal-Mogul Bearing Company; Harry B. Rottiers, Burroughs Corporation; and John Bohmrich, Fruehauf Trailer Company. The Blue team comprised: Roy Camel, Detrex Chemical Industries, Inc., captain; Elmer Gormsen, Chevrolet Division, GMC; L. G. Wiseley, Michigan Consolidated Gas Company; A. H. Hilverkus, Chrysler Corporation; Robert J. Kelly, Detroit Edison Company; Joseph A. Anderson, AC Spark Plug Division, GMC; and Col. E. D. Mohlere.

The team members were the prime movers in keeping up Post membership. On January 9th, the Blues treated the Reds to a special dinner at the Detroit Athletic Club for their superior performance in bringing in new members.

The surprise of the evening—an event that only a few members knew of in advance—was the founding and first award of the Alex Dow Gold Medal. It had but recently been ordered by the Michigan Post officers and directors in honor of Alex Dow, an engineer and industrialist who was president and later board chairman of the Detroit Edison Company and for over twenty years chief of the Detroit Ordnance District. The Dow Medal was authorized just in time to be first presented to General Gavin. In the award ceremony, Mr. Harder read the citation which stated in part:

"He now directs an alert and tireless search for every scientific and technical possibility that would increase the firepower and mobility and perfect the tactics of our ground forces. He would ensure that never again will our soldiers fight a war with obsolescent means."

The medal was bestowed on the general by Mr. Valpey who originally proposed that the Post have its own special award.

General Gavin, after thanking the Post for the honor, gave a vivid presentation of present Soviet military might and a preview of some American armament.

## *Underwater Ordnance Division Meets At Naval Underwater Ordnance Station*

The U. S. Naval Underwater Ordnance Station at Newport, R. I., was host for the secret fall meeting of the A.O.A. Underwater Ordnance Division, October 9-10, 1957. As the program contemplated that the members in attendance would be out of doors a large part of the time, the well-known Division chairman, Adm. A. G. Noble, executive vice-president, Vitro Corporation of America, New York, N. Y., thoughtfully selected the most beautiful time of the year along the northeast Atlantic coast for the date of this meeting!

The first session was called to order at 9:15 a. m. on Wednesday, October 9th by Admiral Noble. He opened the meeting with a word of greeting to members, consultants, and guests and with the reading of the Statement of Policy and Aims of the American Ordnance Association.

Committee meetings were conducted during the morning of October 9th. After luncheon and an address by Comdr. David C. Peto of Submarine Development Group Two, New London, Conn., the Division visited the Naval Underwater Ordnance Station at Newport. A high point of this tour was the excellent torpedo display located at the Torpedo Firing Pier, Gould Island.

**The above group attended the meeting of the Underwater Ordnance Division at the Naval Underwater Ordnance Station at Newport, R. I.**

Thursday morning, October 10th, was devoted to Committee meetings and the executive board meeting.

The second session of the Division as a whole was called to order by Admiral Noble at 1:35 p. m. He announced that the spring meeting of the Division would be held in Panama City, Fla., on March 19-20, 1958. He suggested that the Division members, consultants, and guests plan to register during the afternoon of March 18, 1958. Capt. H. C. Mason will act as coördinator for the Bureau of Ships in the planning of this meeting.

The Division accepted a new problem from Capt. C. B. Stevens, Jr.—the application of "value engineering" to all phases of an engineering program to effect cost reduction. "Value engineering" as used by the Bureau is defined as "those particular efforts in engineering related to cost reduction." Admiral Noble announced that Frank D. Peltier, Philco Corporation, Philadelphia, Pa., would appoint an ad hoc committee to consider this problem.

The members appointed to this committee were: Mr. Peltier, chairman; Raymond L. Barrett, General Electric Company, Pittsfield, Mass.; W. R. Gourley, Philco Corporation, Philadelphia, Pa.; J. Harry Martin, General Electric Company, Pittsfield, Mass.; T. A. Robertson, Vitro Laboratories, Silver Spring, Md.; and Roy C. Schoenhaar, of the Ford Instrument Company, Long Island City, N. Y.

The chairman then called on the following three committee chairmen to report:

Alton D. Anderson, Cook Electric Company, Chicago, Ill., chairman of the Fire Control Committee, who reported that the work of the Committee was carried on principally by three subcommittees. He then called on his subcommittee chairmen to report.

John J. Ryan, W. L. Maxson Corporation, New York, N. Y., chairman of the Records and Communications Subcommittee, reported that his subcommittee had submitted reports on OSTD 599 and design disclosure.

W. G. Shaffer, Vitro Laboratories, Silver Spring, Md., chairman of the Test and Evaluation Subcommittee, reported that his subcommittee had submitted an interim report and described briefly the future test and evaluation work planned by his subcommittee.

M. W. Arsove, Philco Corporation, Philadelphia, Pa., chairman of the Subcommittee on Reliability, reviewed the work of his subcommittee and briefly discussed future plans.

J. McWilliams Stone, president, DuKane Corporation, St. Charles, Ill., chair-

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man of the Mine Committee, reported on the activity of that group. He mentioned that his Committee had developed a set of qualifications through which the Bureau of Ordnance could gage a prospective bidder's job competence. These qualifications are: attitude, technical resources, production capability, quality control, military production know-how, and availability. Mr. Stone stated that an ad hoc committee had been established to consider the applicability of these qualifications for their intended use. He concluded his report by noting that batteries, diaphragms, clock mechanisms, and mine cases continue to be problems in mine ordnance.

Dr. G. R. Tatum, Vitro Laboratories, Silver Spring, Md., who is chairman of the Torpedo Committee, gave a brief description of the operation of his Committee and then requested V. M. Setterholm, also of Vitro in Silver Spring, Md., secretary of the Torpedo Committee, to report on the activities of that Committee.

Mr. Setterholm reported that a subcommittee had been assigned the problem of design disclosure and that this group was doing an excellent job. He then reviewed the activities of the following five ad hoc panels of the Torpedo Committee: Development to Production Transition, under the chairmanship of W. L. Cloninger, Librascope, Inc., Glendale, Calif.; Exploder Safety and Reliability, under the chairmanship of L. L. Burke, American Kitchens Division, Avco Manufacturing Corporation, Connersville, Ind.; Simulator Testing versus Proof Ranging of Torpedoes, under the chairmanship of Roy H. Malm, Minneapolis-Honeywell Regulator Company, Seattle, Wash.; Environmental Specifications for Torpedoes, under the chairmanship of H. E. Ellerman, Westinghouse Electric Corporation, Baltimore, Md.; and Repair Assemblies versus Repair Parts for Torpedoes, under the chairmanship of C. A. Gongwer, Aerojet-General Corporation, Azusa, Calif.

## *Guided Missile and Rocket Division Holds Symposium at Sacramento*

The A.O.A. Guided Missile and Rocket Division held a secret propulsion symposium at the El Rancho Hotel, Sacramento, Calif., on October 7-11, 1957. Due to the unavoidable last-minute absence of Division Chairman C. L. Eksergian, vice-president, engineering, the Budd Company, Detroit, Mich., Weber deVore, manager, Ordnance Division, Heintz Manufacturing Company, Philadelphia, Pa., and deputy chairman of the Division, presided.

C. W. Guy, assistant general manager, Rocketdyne, division of North American Aviation, Inc., Canoga Park, Calif., and chairman of the Propulsion Committee of the Division, was the general chairman of the meeting and responsible for the program and all arrangements.

Tuesday, October 8th, was devoted to a consideration of the economics of missile instrumentation and testing.

An ad hoc committee under the chairmanship of Elmer Wheaton, chief missile engineer of the Douglas Aircraft Company, Santa Monica, Calif., and chairman of the Structures Committee of the Division, presented a series of technical papers to promote an understanding of the costs involved and suggested methods of reducing them.

The day's program consisted of the presentation of the following papers: "Review of Data—Processing Aids," C. L. Adams, Electronic Measurements Branch, Ballistic Research Laboratories, Aberdeen Proving Ground, Md.; "Design of Experiments," John Vanderbeck, head, Test Design and Evaluation Branch, U. S. Naval Ordnance Test Station, China Lake, Calif.; "Minimizing Telemetering Requirements," Hudson Fields, U. S. Naval Air Missile Test Center, Point Mugu, Calif.; "Cost of Precision," Harold Gumbel, head, Technical Programs Analysis Office, U. S. Naval Air Missile Test Center, Point Mugu, Calif.

Also, "How Data Requirements of a Missile Program Change as the Program Matures," Wilmoth Keller, group engineer, Convair Division, General Dynamics Corporation, Pomona, Calif.; and "Some Costly Fears in Missile Testing," R. L. Johnson, assistant chief missiles engineer, Douglas Aircraft Company, Santa Monica, Calif.

The evening session was a panel discussion of the papers presented during the day's meeting as well as a very interesting question-and-answer consideration of the basic subject.

The following served as members of the panel with Mr. Wheaton presiding as moderator: Dr. L. A. Delsasso, chief, Ballistic Measurements Laboratory, Aberdeen Proving Ground, Md.; M. Kuska, chief missile flight test engineer, Northrop Aircraft, Inc., Hawthorne, Calif.; P. W. Ott, U. S. Naval Air Missile Test Center, Point Mugu, Calif.; W. H. Manning, Jr., assistant chief, Data Processing Division, Air Force Missile Test Center, Patrick Air Force Base, Fla.; E. M. McCormick, head, Data Assessment Division, U. S. Naval Ordnance Laboratory, Corona, Calif.; and Dr. D. T. Sigley, chief engineer, Guided Missile Division, Firestone Tire & Rubber Company, Los Angeles, Calif.

During the course of the day's deliberations, Chairman Wheaton paid tribute to the late Maj. Gen. Louis Bell of the Ordnance Corps, U. S. Army. General Bell, as commanding general of the White Sands Proving Ground, N. Mex., and later as Assistant Chief of Army Ordnance in charge of research and development activities, had worked long and hard in endeavoring to solve the involved problems discussed during the day.

The technical and economic aspects of missile and rocket propulsion were discussed at the Wednesday sessions of the meeting. David W. Fletcher, U. S. Steel Corporation, chairman of the A.O.A. Rocket Committee, and Andrew J. Peterson, Goodyear Aircraft Corporation, chairman of the A.O.A. Jato Committee, were cochairmen of the meeting.

The theme of Wednesday's meeting on "New Control Devices and Fabrication Techniques and Materials" was carried out with the presentation of the following papers:

"Deep Drawing the Hawk Motor Tube," Larry Shiller, Norris-Thermador Corporation; "Development of Hardware for Large Rocket Motors," J. A. McBride, Phillips Petroleum Corporation; "One-piece Rocket Heads," J. E. King, Heintz Manufacturing Company; "M-5 (Nike) Jato Manufacturing" (motion picture), J. R. Stair, Goodyear Aircraft Corporation; "Engine Accessories," J. W. Wiggins, Thiokol Chemical Corporation.

Also, "A Joining Method for Jato Components," Ludwig Roth, Solar Aircraft Company; "Fabrication of Parts by Power Spinning," J. Switak, Borg-Warner Corporation; "Views of Army Ordnance on Solid Propulsion," Col. C. W. Clark, Office, Chief of Army Ordnance; "Advance in Solid and Liquid Rockets," W. E. Campbell, director, quality control, Aerojet-General Corporation; "Liquid Propulsion Systems," Col. Langdon Ayers, Headquarters, ARDC; "Requirements for Advanced Rocket Engine Systems for Navy Guided Missiles," Capt. Levering Smith, U.S.N., Comdr. R. Kaufman, U.S.N., and Comdr. J. E. Dodgen, U.S.N.; "Future Trends in High-performance Propellants," Dr. Eugene Miller, Olin Mathieson Chemical Corporation.

An official reception and dinner were arranged on Wednesday evening at the Sutter Club in Sacramento. Mr. deVore presided. (*Continued on p. 840*)

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## Association Affairs (Contd.)

William E. Zisch, vice-president and general manager, Aerojet-General Corporation, Mr. Wheaton, and Mr. Guy, cordially welcomed the visiting members of the American Ordnance Association in behalf of the presidents of their respective corporations. Brig. Gen. Burton O. Lewis expressed the cordial greetings and best wishes from national A.O.A. headquarters in Washington to all present.

Louis Polk, president, the Sheffield Corporation and vice-president, Bendix Aviation Corporation, who is also A.O.A. vice-president in charge of technical activities, officially welcomed all those attending this important technical meeting. He expressed the deep appreciation of the Association to those three corporations whose working coöperation and gracious hospitality had made the meeting such an outstanding success.

Toastmaster deVore then introduced the principal speaker of the evening, Maj. Gen. Leighton I. Davis, U.S.A.F., Commander, Air Force Missile Development Center, Holloman Air Force Base, N. Mex. General Davis presented an illustrated address covering the important testing activities currently being carried on at the proving ground under his command. He also explained how the operations at the Holloman Air Force Base fitted in with related activities of other technical centers in the development and testing of new Air Force matériel.

This informal evening meeting afforded an unusual opportunity for the representatives of government and industry to become better acquainted and to discuss mutual problems and experiences.

On Thursday, October 10th, the members met at a 7 o'clock breakfast at the Sutter Club as guests of the Sacramento Chamber of Commerce. The visitors were cordially welcomed by the Mayor of Sacramento and by the president of the Chamber of Commerce. After an excellent California breakfast and appropriate briefings, the group was taken on a tour of the Sacramento area.

The morning was devoted to guided tours of the Douglas Aircraft Corporation plant, Aerojet-General liquid and solid rocket plants, ending in the early afternoon with a buffet luncheon at the Aerojet-General Corporation's plant cafeteria. During the afternoon the members witnessed a series of rocket firings at the Aerojet-General test range.

This 3-day meeting of the Guided Missile and Rocket Division of the A.O.A. was voted an outstanding success in every respect by all of those in attendance who were unanimous in extending their sincere thanks to the three industrial corporations and to the individuals who had made the meeting possible.

## Cumberland Valley Post Established With Dinner At Mechanicsburg, Pa.

The Cumberland Valley Post, the thirty-ninth Post of the A.O.A., was established at a well-attended dinner meeting in the Navy Supply Center, Mechanicsburg, Pa., on Thursday, January 9th. This newest Post was originally a Chapter of the same name under the Philadelphia Post. The occasion was celebrated at the Officers' Club where William H. Strauss, Waynesboro Manufacturers' Association, was presiding officer.

After the invocation by the Rev. Benjamin Lavey, rector of Trinity Episcopal Church, Chambersburg, Pa., Mr. Strauss welcomed the assembly and introduced the following distinguished guests at the head table: Capt. D. S. Embree, assistant commanding officer, Ordnance Stock Office; Brig. Gen. R. W. Daniel, Post vice-president; Col. W. F. Rader, commanding officer, Letterkenny Ordnance Depot; Comdr. James S. Spore, Naval Supply Center; and Col. Wilber Planck of Gettysburg.

In the election of the charter Post officers and directors, the energetic and genial Bill Strauss was elected to continue as leader of the new Post, the position he has filled so ably for the past two years for the Chapter.

The charter was presented by Capt. J.M.P. Wright, of A.O.A. headquarters, who welcomed the Post into the Association on behalf of the national Board of Directors. It was pointed out that the membership of the founding chapter had grown from 40 to 220 members.

Rear Adm. J. B. Ricketts, commander of the Naval Supply Center, was called upon to introduce the guest speaker, Lieut. Comdr. Edward Biddle, with the Director of Atomic Energy, Office, Chief of Naval Operations.

Commander Biddle developed his subject of atomic reactor programs in a most interesting fashion. He enumerated the present industrial reactors that are in various stages of completion and explained the difference in the type of moderators to be used in the various parts of the country. He said that until 1965 the water-type reactors have the most promise in competition with usual forms of power plants. After that, other novel types under development by the Atomic Energy Commission may become more efficient.

Commander Biddle then outlined the naval reactor program, explaining the various types to be used in our submarines, antisubmarine submarines, large ships, and destroyers. He talked in glowing terms of the vast increase in fleet flexibility that will be obtained when an

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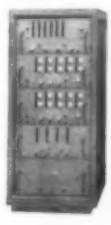

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entire task force can be equipped with nuclear-powered ships. His talk was not only extremely informative but well presented with good displays.

## *Maj. Gen. Robert J. Wood Addresses Washington Post at December Meeting*

The December 19th luncheon meeting of the Washington Post at the Army-Navy Country Club near Washington, D. C., was inspired by an excellent address by Maj. Gen. Robert J. Wood, Deputy Chief of Research and Development of the Army.

W. J. Sears, Post president, presided and introduced the following distinguished guests at the head table: Lieut. Gen. George W. Mundy, U.S.A.F., commandant, Industrial College of the Armed Forces; O. P. Latue, executive director of the Military Petroleum Supply Agency; Elmer Statz, executive officer, Coördinating Board of the National Security Council; Hon. Dudley Sharp, Assistant Secretary of the Air Force for Matériel; Ernst A. Tupper, first vice-president of the Washington Post; Patrick Lizza, president of the Los Angeles Post; and J. McWilliams Stone, Chairman of the Mine Committee of the A.O.A. Underwater Ordnance Division and president of Du-Kane Corporation.

General Wood chose for his principal theme an examination of the six recommendations made by Senator Johnson's preparedness subcommittee. The general discussed each recommendation and gave his personal views on the effectiveness of each. He was especially critical of putting missiles under a single director but was entirely in favor of establishing research and development programs on a long-range instead of a yearly basis and of eliminating overtime restrictions.

General Wood, in connection with the recommendation to reduce lead time by making early and firm decisions, took the opportunity to analyze the article of Prof. J. S. Livingston of Harvard Business School on the new design for defense.

The general had some excellent comments to make on Dr. Livingston's thesis, showing that several of the proposals were, in his opinion, either not practical or not in accordance with the experience of those in the military service who were fully familiar with new weapon development. General Wood concluded by proposing that, with slight improvement, our present weapon development procedure was good but that the development of space vehicles and satellites could be handled more effectively with a central agency located within the Department of Defense.

The Washington Post met again on January 16th in its customary locale to honor Rear Adm. Rawson Bennett, II, Chief of Naval Research. Post President W. J. Sears announced the change of date and place for the February meeting at which Rear Adm. F. S. Withington would be honored upon his detachment to duty as Commander, Naval Forces, Japan. He also informed the audience that R. P. Williams, a member of long standing and a director of the Post, had been critically injured. (Mr. Williams died on February 14th.—EDITOR.)

Distinguished guests at the head table were: Maj. Gen. F. A. Hansen, Chief of Field Service, Office, Chief of Ordnance; Rear Adm. A. G. Mumma, Chief of the Navy Bureau of Ships; Brig. Gen. S. R. Shaw, Deputy Chief of Staff for Research and Development, U. S. Marine Corps Headquarters; Gen. Jacob L. Devers, Fairchild Engine and Airplane Corporation and a director of the Post; Capt. E. B. Hooper, Assistant Chief for Research and Development, Navy Bureau of Ordnance; F. B. Zoll, Libbey-Owens-Ford Glass Company, a Post director; and Col. Leo A. Codd, executive vice-president, A.O.A.

A special welcome was tendered Maj. Gen. E. P. Mechling, U.S.A.F., Ret., who has just joined the headquarters organization of the American Ordnance Association after serving many years as Commander, Air Force Armament Center, Eglin Air Force Base, Fla.

Admiral Bennett, in his thought-provoking talk, stressed that this is an unusual era in this country where the decisions made could affect the future of the world. He expressed the belief that this period is comparable to the early 1930's when important decisions had to be made affecting our future.

The admiral outlined the three major fields in which he declared our citizens must take a vital interest and not sit back

(*Continued on p. 844*)

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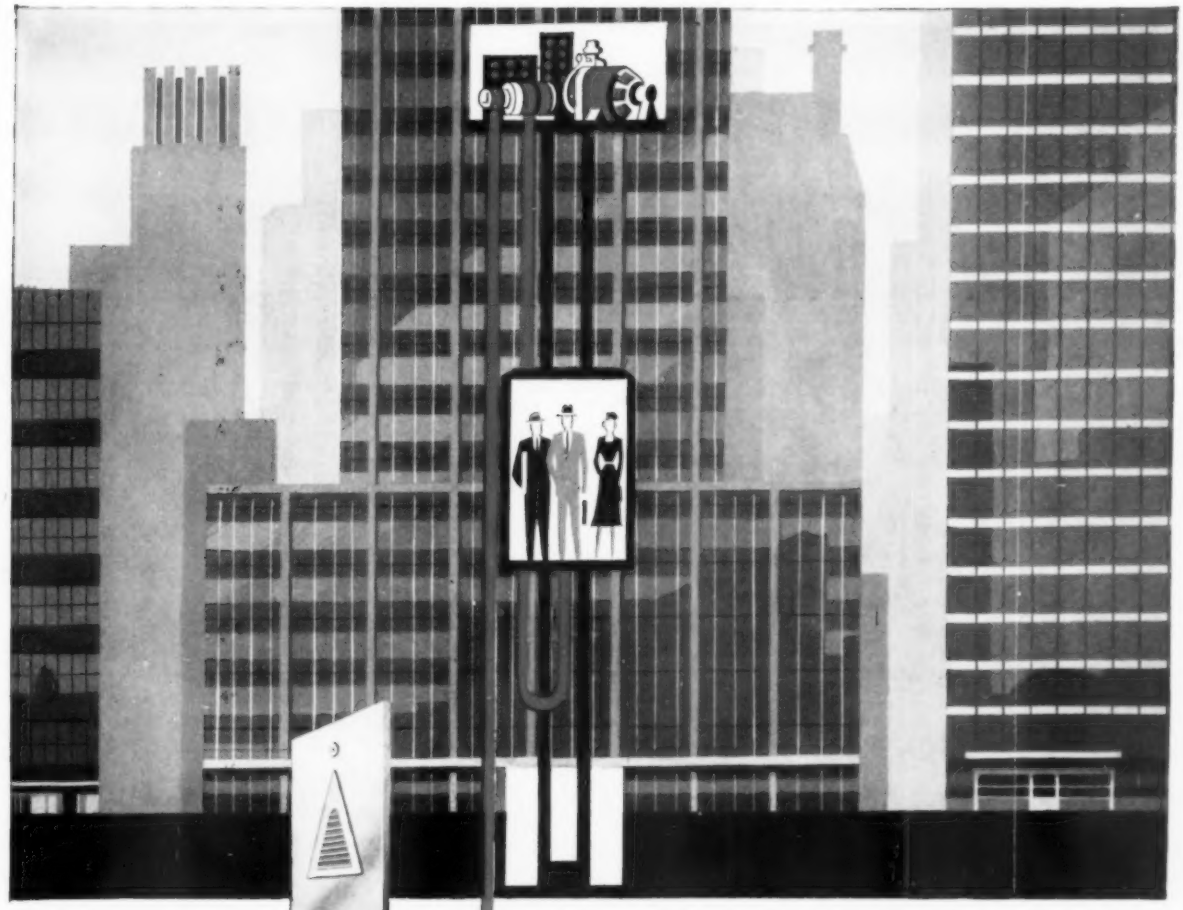

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expecting our leaders to solve them alone. One such field was international policy—should we truly help to stabilize the economy of weaker nations or merely support a military giveaway program? Further, in the face of many demands, can we negotiate with the Russians in spite of their many broken agreements?

In the area of our military defense policy, should there be more centralization or a decentralization? Before great changes, should we not try to put in order the present administrative scheme of things? Admiral Bennett noted that the Gaither and Rockefeller reports contain some dire forebodings primarily pointed to the need for eternal vigilance and planning based on long-range objectives.

Regarding educational policies, Admiral Bennett asked, "What good is it to save the world today if it goes down the drain tomorrow?" Our future depends on the saneness with which we direct our educational system. He advised that each citizen examine his own interest in the education of his children. Are we insisting on good teaching and helping our community to acquire good teachers?

In conclusion, the admiral warned we should examine closely any tendency to place all our bets on one deterrent weapon such as the ICBM and concluded with the title of his address, "Missiles—then what?"

## J. Lewis Powell Addresses Birmingham Post January Meeting at Country Club

At Birmingham, the Post held its annual dinner meeting at the Birmingham Country Club on Friday, January 10th. Post President Richard M. Donahue, vice-president of Line Material Company, Birmingham, Ala., presided.

The highlight of the evening was the presentation by J. Lewis Powell, Office of the Assistant Secretary of Defense, Supply and Logistics, of his inimitable talk on "The Collapse of Time." The audience was delighted with Mr. Powell's crackling humor and startling portrayal of the fabulous technological progress that has been made in the past twelve years.

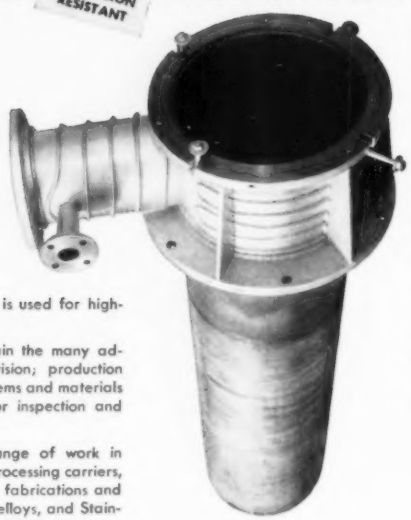
It was evident that the Birmingham Post members, representing the main industrial strength of the South, were more than ready to accept the challenge of planning for progress put forward by the speaker.

Others who were called on for brief appearances were Warren Whitney, a past president of the Post, who introduced Col. Harold R. Lang, Ordnance Officer, Third Army, and formerly commanding officer of the Birmingham Ordnance District. Colonel Lang expressed his pleasure over being with his many friends and pledged his support to the A.O.A. of the Southeast. Capt. J. M. P. Wright, A.O.A. Washington headquarters, made a brief report on national Association affairs and presented a certificate of appreciation to Col. William J. Rushton, immediate past President of the Post, wartime chief of the Birmingham Ordnance District, and a loyal adherent of the Association for many years.

The nominating committee's acting chairman, Warren Whitney, presented the following slate of officers and directors that was accepted unanimously: President, R. S. Lynch, Atlantic Steel Corporation; Vice-presidents: A. B. Schwarzkopf, U. S. Pipe and Foundry Company, and J. Frank Curry, Protective Life Insurance Company; Secretary, Col. Ralph E. Parker; Treasurer, Robert D. Cotten, Clark-Cotten Mortgage Company; Directors: J. Lindsay Bilder, Rudisill Foundry Company; R. C. Harris, Harris Foundry & Machine Company; Col. Roy D. Hickman, Alabama Engraving Company; Lewis F. Jeffers, Hayes Aircraft Corporation; Thomas E. Kilby, Jr., Kilby Steel Company; P. S. Knox, Jr., Knox Metal Products Company; Claude S. Lawson, U. S. Pipe and Foundry Company; K. B. McMasters, Sherwood Moore Iron Works; Russell H. Pedigo; Merrill Pratt, Continental Gin Company; Col. William J. Rushton, Protective Life Insurance Company; Herbert E. Smith, Jr., Vulcan Rivet & Bolt Corporation; Mr. Whitney, National Cast Iron Pipe; Arthur V. Wiebel, Tennessee Coal & Iron Division, U. S. Steel Corporation; National Council Representative, Col. William J. Rushton; Member at Large of Council, Richard M. Donahue.

Mr. Lynch, in accepting his office, invited the membership to hold its next annual meeting in Atlanta and predicted that there soon would be a noticeable increase in A.O.A. members in Georgia.

ROLOCK
SPECIALIZED WELDED HEAT AND CORROSION RESISTANT FABRICATIONS
for example
VACUUM RETORTS



This heavy INCONEL Vacuum Retort is one of a number of such designs being produced by ROLOCK. Approximately 2 feet in diameter by 8 feet high, it is used for high-temperature vacuum annealing.

By entrusting such work to ROLOCK, you gain the many advantages of competent engineering supervision; production personnel thoroughly experienced in the problems and materials involved; a modern plant fully equipped for inspection and testing as well as fabrication.

Rolock facilities and skills cover a wide range of work in pressure and vacuum equipment, specialized processing carriers, furnace retorts, covers and bells, trays, tanks, fabrications and assemblies in Inconel, Incoloy, Monel, the Hastelloys, and Stainless Steels. Send us an outline of your requirements.

Put your problems up to:
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## A.O.A. Artillery Division Holds Secret Meeting At Rock Island Arsenal, Ill.

The 1957 annual meeting of the A.O.A. Artillery Division held at the Rock Island Arsenal, Ill., on October 3, 1957,

OPERATION FARSIDE

## From "off the shelf" to thousands of miles into space

Balloon-carried to 100,000 feet and launched up through the big bubble, the four-stage Operation Farside missile achieved the greatest height ever attained by a man-made object—an estimated 4,000 miles to the edge of outer space.

A cluster of four Thiokol solid propellant Recruit engines supplied the critical first stage take-off thrust, followed by a single Recruit as the second stage.

Farside again emphasized the flight reliability of Thiokol solid propellant rocket engines, whether ground, sea or air-launched. And the five Recruit engines were standard "off-the-shelf" models. The Recruit has been proven time after time for power and performance. Since the engine is a regular production item, precious time and dollars were saved for the Farside project. Operation Farside was developed by Air Force Office of Scientific Research, ARDC, and Aeroneutronics Systems, Inc.

Thiokol®

CHEMICAL CORPORATION

TRENTON, N. J. · ELKTON, MD.
HUNTSVILLE, ALA. · MARSHALL, TEXAS
MOSS POINT, MISS. · BRIGHAM CITY, UTAH

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was classified secret. J. E. Trainer, executive vice-president, Firestone Tire & Rubber Company, Akron, Ohio, as chairman of the Artillery Division opened the meeting and introduced Col. Daniel L. Hine, commanding officer of the Arsenal, who welcomed the visiting members of the A.O.A. and expressed his official appreciation of the valuable technical assistance that had been given by this group over the years in the development of mobile artillery.

Chairman Trainer then introduced Brig. Gen. Burton O. Lewis who brought cordial greetings and best wishes for another successful meeting from national A.O.A. headquarters in Washington. General Lewis also expressed the sincere regrets of Gen. Benjamin W. Chidlaw, president of the Association, and Louis Polk, vice-president in charge of Technical Divisions and Committees, who were unable to be present at this meeting as planned.

The speakers and their subjects at the technical sessions were: Brig. Gen. W. K. Ghormley, commanding general, Ordnance Weapons Command, Rock Island Arsenal, "Transition from Research and Development to Production and Supply"; Dr. V. Lucas, Firestone Tire & Rubber Company, Akron, Ohio, "New Shell Developments"; Col. Samuel Smellow, Research and Development Division, Office, Chief of Army Ordnance, Washington, D. C., "Artillery Is Not Yet Dead"; Edgar T. Horn, Rock Island Arsenal, "New Developments in Conventional Artillery"; R. J. O'Brien, Armour Research Foundation, Chicago, Ill., "Launcher for Rocket-assisted Projectiles"; Arnold A. Kester, Rock Island Arsenal, "Special Rocket Launcher"; G. E. McNeil, Jr., Ordnance Weapons Command, Rock Island Arsenal, and Edwin Zarookian, Sperry Gyroscope Company, Great Neck, N. Y., "High-velocity Gun Program."

Conducted tours of the Rock Island Arsenal shops, laboratories, and storehouses were arranged for members having special interests in these departments.

A social hour and dinner was enjoyed by all at the Black Hawk Hotel, Davenport, Iowa, during the evening.

## Metal Working Lubricants Committee Holds Meeting Aboard Aircraft Carrier

The twelfth meeting of the Metal Working Lubricants Committee, Advisory, Technical and Research Group, American Ordnance Association, was held aboard the U.S.S. Essex off Mayport, Fla., on November 7, 1957.

The Committee assembled on the evening of November 6th at the Naval Air Station, Jacksonville, Fla. After spending the night in the bachelor officers' quarters at that station, the Navy flew the group out to the U.S.S. Essex and back again in the evening after the meeting.

William J. Reitze, Esso Standard Oil Company, New York, N. Y., chairman of the Committee, called the meeting to order at 11 a. m. on board the Essex. Comdr. C. S. Walline, executive officer, welcomed the A.O.A. group aboard and described the ship, its mission, duties, and operation.

Henry N. Marsh, general chairman, Technical Divisions and Committees, representing A.O.A. headquarters, extended his greetings and stressed the valuable work being done by this Committee. He also expressed to the Navy officials of the Essex and the Naval Air Station in Jacksonville the sincere thanks of the officers and directors of the American Ordnance Association for their outstanding coöperation as hosts to this meeting.

After the business session the meeting was adjourned and the Committee members were taken on specially conducted tours of the ship. This facilitated the mutual discussion on metal lubrication problems by the Navy personnel with members of the A.O.A. Committee.

The following letter to the Hon. Thomas S. Gates, Jr., Secretary of the Navy, by Mr. Reitze, Committee chairman, best expresses the appreciation of all present for this day at sea with the U. S. Navy:

"In behalf of the Metal Working Lubricants Committee of the American Ordnance Association, I wish to express our appreciation for the courtesies and hospitality extended to us in connection with our meeting on November 7th aboard the U.S.S. Essex. The arrangements and facilities were excellent, and it will be a long time before any of us forget the thrill of landing on and taking off from the deck of an aircraft carrier.

"Our meeting's success was the result of the fine coöperation and hard work on the part of many Navy units. Everyone we met or talked to was most pleasant and helpful. We all left the meeting with a sincere feeling of pride and confidence in our Navy and its people. I would like to mention a few of your people to whom we owe a real debt of gratitude:

"Rear Adm. W. G. Sweitzer, Comdr. Ralph M. Kingsley, and Ensign Ronald H. Kent, who took care of us at the

(*Continued on p. 849*)

ACCURACY
in modern scientific
instruments often depends on controlling
the direction of light without:
DISTORTION • DIFFRACTION
DIFFUSION
Consult the pioneers in evaporated metal coatings for:
- first surface mirrors with half-wave protection
- semi-transparent mirrors metallic and non-metallic
- beam splitters
- optical filters

Send for our free booklet. We have experience and skill to put at your service in solving your individual light problem.

EVAPORATED METAL FILMS CORP.
Ithaca, New York
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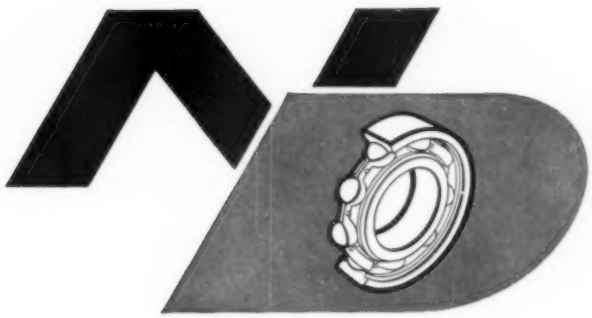
NEW DEPARTURE

NEW DEPARTURE

NEW DEPARTURE



*Symbol of a Reputation*

. . . a reputation for integrity, for quality and service . . . for advanced creative engineering achieved by New Departure in over half a century of precision ball bearing manufacture.

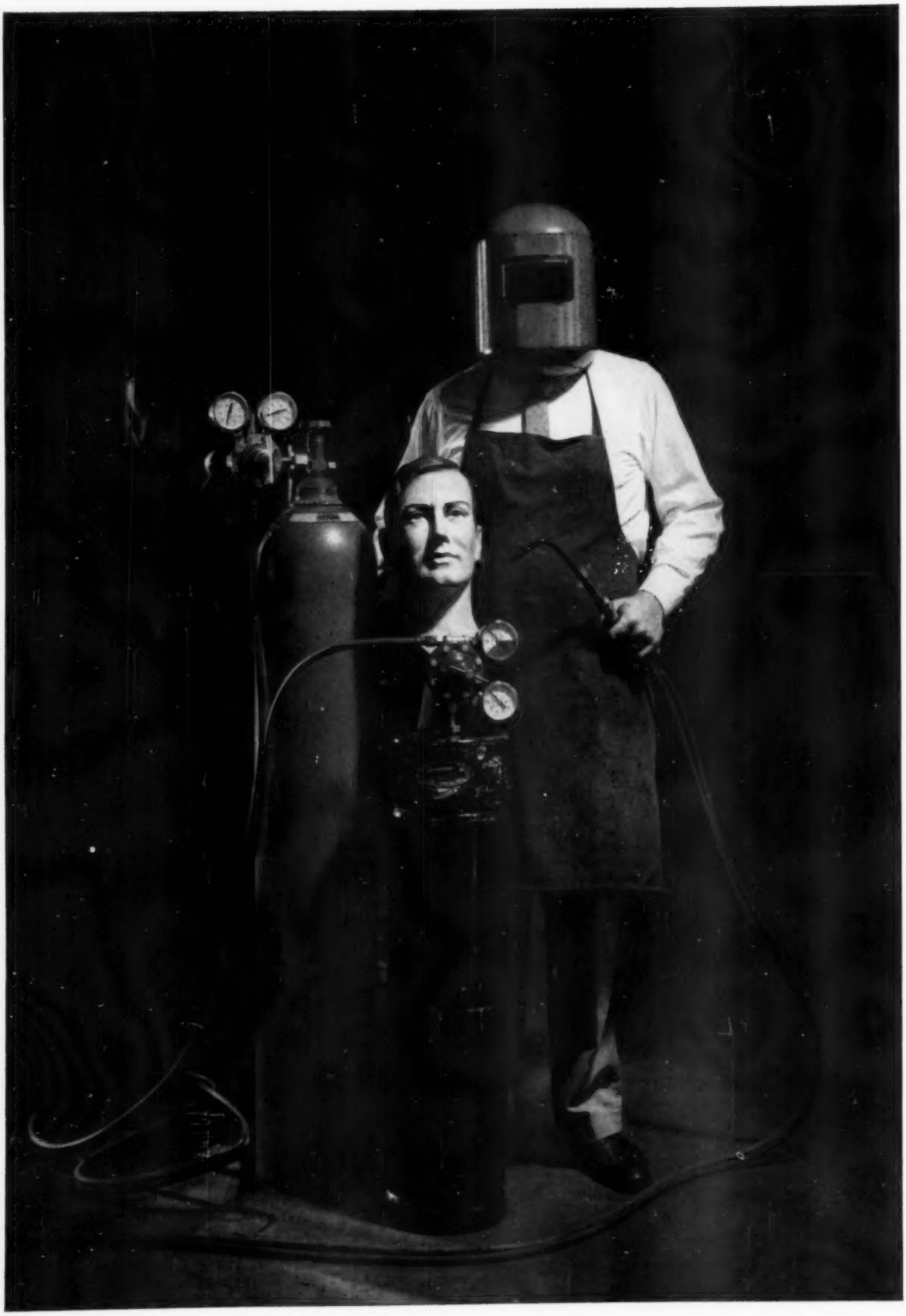
You'll find this emblem is also symbolic of our determination to continue, in the fullest measure, all those factors which have built that reputation. It is a visual pledge of this resolution to all our customers, present and future.

*turning point of modern industry*

1908–1958 GM FORWARD FROM FIFTY

NEW DEPARTURE

DIVISION OF GENERAL MOTORS—BRISTOL, CONN.



Is it possible to build a **MAN?**

"Theoretically, yes," said the scientist. "Or a reasonably remarkable imitation—a kind of mechanical analogue. Call it a habit machine, a mechanism operating according to the laws of the conditioned reflex."

*You mean that you could actually build a mechanical mind? One that would exhibit emotions—such as love, fear, anger, loyalty?*

"We're doing something like that now in advanced missile development," the scientist replied. "In a limited, highly specialized way, of course."

"Take the 'pilot' that is being developed for the big long-range missile. *He* has a wonderful memory, and can solve many complex navigational problems in a flash. *He* loves perfection, and actually becomes highly excited when *he* gets off course. *He's* a tough-skinned character, impervious to the cold at several hundred miles altitude and the incredible heat at re-entry. And *his* loyalty is heroic. *His* life is a single mission, the mission *his* whole life... and maybe ours, too. *He's* a pretty important *fellow.*"

*What about the complete man-made Man? What would that entail?*

"A mechanism the size of the capitol in Washington, and the best scientific resources in the world. But it could be done. You see, it's only a question of how physical matter is organized. As a great biophysicist explained, 'If material is organized in a certain way, it will walk like a man. If it is organized in another way, it will fly like a missile.'"

*Still, wouldn't there be something missing in the complete man-made Man—something very important?*

"Yes," said the scientist. "A soul."

**MARTIN**

BALTIMORE·DENVER·ORLANDO

## Association Affairs (Contd.)

Naval Air Station the night before our meeting.

"Comdr. R. H. Smith and Mr. Andrew Planey who worked with Ensign Kent to arrange for our visit, including bus transportation to and accommodations at the Naval Air Station, Jacksonville, the night before our meeting.

"Comdr. W. S. Adami, Fasron 6, and his very capable pilots who flew us out to the U.S.S. Essex and return.

"Capt. T. A. Christopher and Comdr. C. S. Walline and all their people who were such good hosts aboard the U.S.S. Essex.

"Rear Adm. E. B. Taylor and Comdr. E. O. Saltmarsh of the Office of Information, Navy Department, Washington, who helped in many ways to make the arrangements necessary for us to hold our meeting aboard an aircraft carrier.

"The entire membership of the Metal Working Lubricants Committee joins me in thanking you and your capable associates for making so many of your facilities available and in permitting us to see an important segment of our Navy in action."

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## China Lake Chapter Reports Interesting Meetings And Talks During the Past Year

The A.O.A. at China Lake, Calif., reports great activity during the past year. The first meeting was held in Michelson Laboratory, February 18, 1957, when C. E. Juran and George Batchelder of the Grand Central Rocket Company described "The Third-stage Propulsion Unit for the Vanguard Satellite."

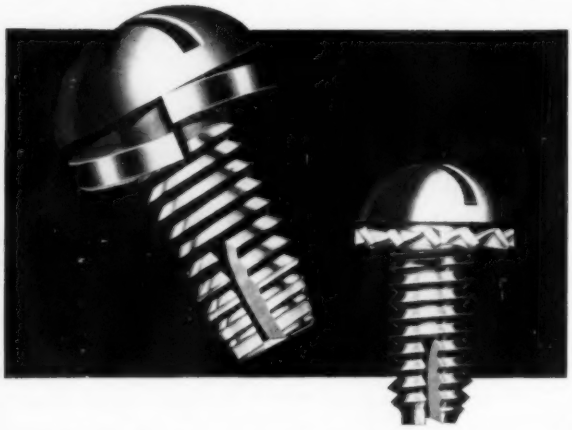
On March 25th, Wayne Martin, of Lyon, Inc., Detroit, Mich., spoke on "The Lyon Method of Producing Deep-drawn Cases for Large Motor Chambers and Bombs"; and on June 10th Harold Metcalf, head of the Development Engineering Division of the Propellants and Explosives Department, Naval Ordnance Test Station, discussed "Manufacture of Large Missile Propulsion Charges from Propellant Segments."

At the fourth meeting, lunch at the Officers' Mess on October 7th, Comdr. Wade Cone presented a program on "Sidewinder at Work," including a report on fleet evaluation of Sidewinder.

At the latest meeting on January 20, 1958, 163 members and guests heard the technical director of NOTS, Dr. W. B. McLean, speak on "Satellites."

J. L. Cox has been elected Chapter Chairman.

# FIT RIGHT FASTEN TIGHT



***Production and profits improve with***

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**THREAD-CUTTING SPRINGTITES & SEMS**

Eaton-Reliance Thread-Cutting Springtites and Sems reduce production costs by eliminating tapping. Since they are preassembled screws with either helical or tooth type washers, additional production line savings are made possible.

Industry has found these "fast" fasteners seat firmly without thread stripping or mismating. They are easy to use, easy to store and because of their high quality, add value to your products. Available in round, fillister, pan, truss or hex type heads with either slotted, Phillips or clutch recesses. Write for Engineering Bulletin S-49A.

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# NEW DEVELOPMENTS

### ULTRALIGHTWEIGHT VEHICLE

The Army has awarded a research and development contract to the Dow Chemical Company to build a magnesium hull for an ultralightweight armored vehicle. The hull will be constructed of thick plates of an experimental alloy, about half the weight of commercial aluminum of the same thickness.

If successful, the new vehicle will weigh less than one third as much as models now in use. It will be extremely mobile, yet will provide adequate protection against small-arms fire and fragments.

Dow is working closely with the Detroit Ordnance Tank-Automotive Command on the vehicle. The company also is coördinating with Food Machinery and Chemical Corporation, of San Jose, Calif., which is building another version of the vehicle.

### UNDERWATER MISSILES

A new series of lightweight acoustic-homing torpedoes will give naval ships and aircraft an added punch to meet enemy undersea threats.

One of the newly perfected torpedoes, the Mark 43, can be launched from either surface vessels or airplanes; the other, the Mark 32, from ships only.

The Mark 43, originally constructed from lightweight materials to meet an urgent need for aërial torpedoes, was found to be equally easy to launch from surface ships and now arms fleet antisubmarine aircraft and destroyers.

Actually a submersible guided missile, about eight feet long and ten inches in diameter, the weapon is capable of searching to great depths for enemy targets.

Weighing only about one-eighth as much as World War II aërial torpedoes, the Mark 43 is propelled by an electric motor powered by a storage battery. The Mark 32, in addition to the sound-homing feature, does not have to be fired from a torpedo tube but is merely tossed over the side of a ship from an open launcher. (See illustrations on page 826.)

### RAMJET TESTER

The Lockheed X-7 missile, said to be the fastest of its type in the U. S., has successfully flight tested the large, powerful engine which will propel an operational ramjet missile now in production. The X-7 travels through the thin air of the upper atmosphere at several times the speed of sound, powered by the giant "flying-stovepipe" engine. The ramjet is built by the Marquardt Aircraft Company of Van Nuys, Calif. Exact dimensions and power of the engine are still classified. The X-7 is also testing an even more powerful ramjet, likewise built by Marquardt, on flights over the desert range at the Air Force Missile Development Center, Alamogordo, N. Mex.

### NEW NAVIGATION SYSTEM

A new electronic air navigation system, which for the first time instantaneously gives the pilot his true course and ground speed over land or sea, is being evaluated by Pan American World Airways, Inc. The device, called Radan (radar doppler automatic navigator), developed and manufactured by General Precision Laboratory of Pleasantville, N. Y., will be used on all of Pan American's forty-four jet airliners—the first of which will be delivered this year. (*Continued on p. 852*)

***a step beyond push-button warfare!***

# TALOS

*This Talos launching from the RCA Defense System on Dec. 13, 1957, resulted in direct hit on distant drone plane.*

The RCA Talos Defense System is the first *completely automatic* land-based system for launching and guiding missiles, and utilizes the Talos Missile developed by the Applied Physics Laboratory and produced by Bendix. The Defense Unit receives target signals from remote outposts, analyzes them with regard to number of attackers, location, course and speed. Next, computers determine the logical points of interception, order the missiles loaded on launchers, guide them at supersonic speed to the vicinity of the target, after which the missiles "lock" on the target and close in for its destruction. All without even the touch of a button! The RCA Talos Defense System, with its electronic equipment and guidance systems, was designed, developed and built by RCA as prime contractor, aided by many subcontractors. It was turned over to the U. S. Army on October 15, 1957, and is a missile milestone, exemplifying the continuing determination of American enterprise to secure peace with honor and justice.

**RADIO CORPORATION of AMERICA**

DEFENSE ELECTRONIC PRODUCTS

CAMDEN, N. J.

Tmk(s) ®

The Radan system weighs only eighty-nine pounds and operates independently of any ground-based or celestial aids. It gives accurate, continuous data to navigate the aircraft in any kind of weather and over any terrain. Obtaining the basic information of ground speed and drift angle, and combining it with the compass heading will make possible for the first time in navigational history accurate long-range aërial navigation independent of ground or celestial aids.

### ARMY LOOKS AHEAD

In addition to atomic weapons, the following innovations are forecast for the Army by 1962:

Helmet radio communications for individual riflemen.

Punch-card data-processing machines for company commanders to record and compile operations and intelligence information.

Dial radio telephone systems in combat zones.

Aërocycles, flying platforms, and nuclear-powered, remote-controlled aërial cargo carriers for the battlefield.

Improved medicines and techniques for treating atomic warfare casualties.

Tomorrow's Army will be fed on irradiated perishables treated with radioactive isotopes to prevent spoilage and highly palatable precooked dehydrated foods requiring only the addition of hot water to make them edible.

Although most Army missiles will be able to deliver nuclear warheads, troops will be provided with a variety of both "wonder" and traditional weapons to enable them to apply force measured to particular military situations.

### MISS-DISTANCE INDICATOR

A precise electronic device that tells antiaircraft gunners how close their missiles come to the target has recently been perfected at the Naval Ordnance Laboratory. Used both to develop better antiaircraft weapons and to train missile and gun crews, the newly disclosed "miss-distance indicator" makes it possible to determine the distance in feet by which a missile failed to hits its target.

The MDI automatically records its findings on sensitized paper for immediate analysis of the missile's closest approach to the target aircraft. The system can be applied equally well to rockets, supersonic missiles, or conventional artillery shells.

### JET CONTROLS TESTED

Development and testing of automatic control systems for turbojet and ramjet engines as well as for guided missiles and high-performance aircraft are being conducted at the Sperry Gyroscope Company's advanced jet engine control laboratory on Long Island, where the intense heat and high pressures encountered by supersonic and hypersonic aircraft flying at speeds up to 4,000 miles an hour are reproduced. The facility is used to help the company design and test automatic engine controls required safely to sustain these high speeds, achievable in many cases through the use of so-called exotic fuels.

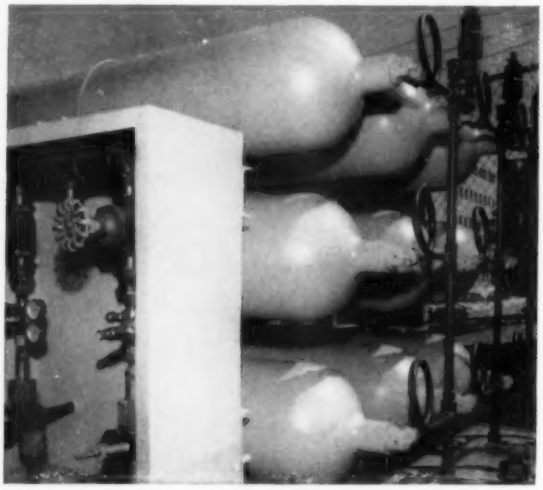
### TURBONATOR

A new self-cooled aircraft device which uses air pressure to generate electricity with air as a lubricant is one of the latest innovations in the heat-barrier battle. Called a turbonator, the device consists of a small turbine wheel mounted on the shaft of an electric generator. Either ram air or air from the airplane's jet-engine compressors is directed at the turbine wheel and after driving the generator becomes so cool that it can be used for air conditioning. In addition, air forced between the main rotating parts serves as a lubricant in place of grease or oil.

For future aircraft, whose speeds will generate temperatures of over 600 degrees Fahrenheit, the turbonator will provide

U. S. NAVAL HOSPITAL

stores oxygen at 3,000 psi
in National SEAMLESS
Steel Cylinders



THE U. S. NAVAL HOSPITAL at San Diego, California, is using nine 47.5-cu.-ft.-capacity National Seamless Steel Cylinders to store oxygen at 3,000 psi. Each cylinder is approximately 33 feet, 9 inches long, with 18-inch O.D. x .750-inch wall.

Whatever gas you store, under whatever pressures, you can rely on USS National Seamless Steel Cylinders to provide the very ultimate in strength and dependability. Pierced from solid billets of highest-quality steel, each cylinder undergoes a severe hydrostatic test before it ever leaves the mill.

For more information on National Seamless Cylinders for gas storage, write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

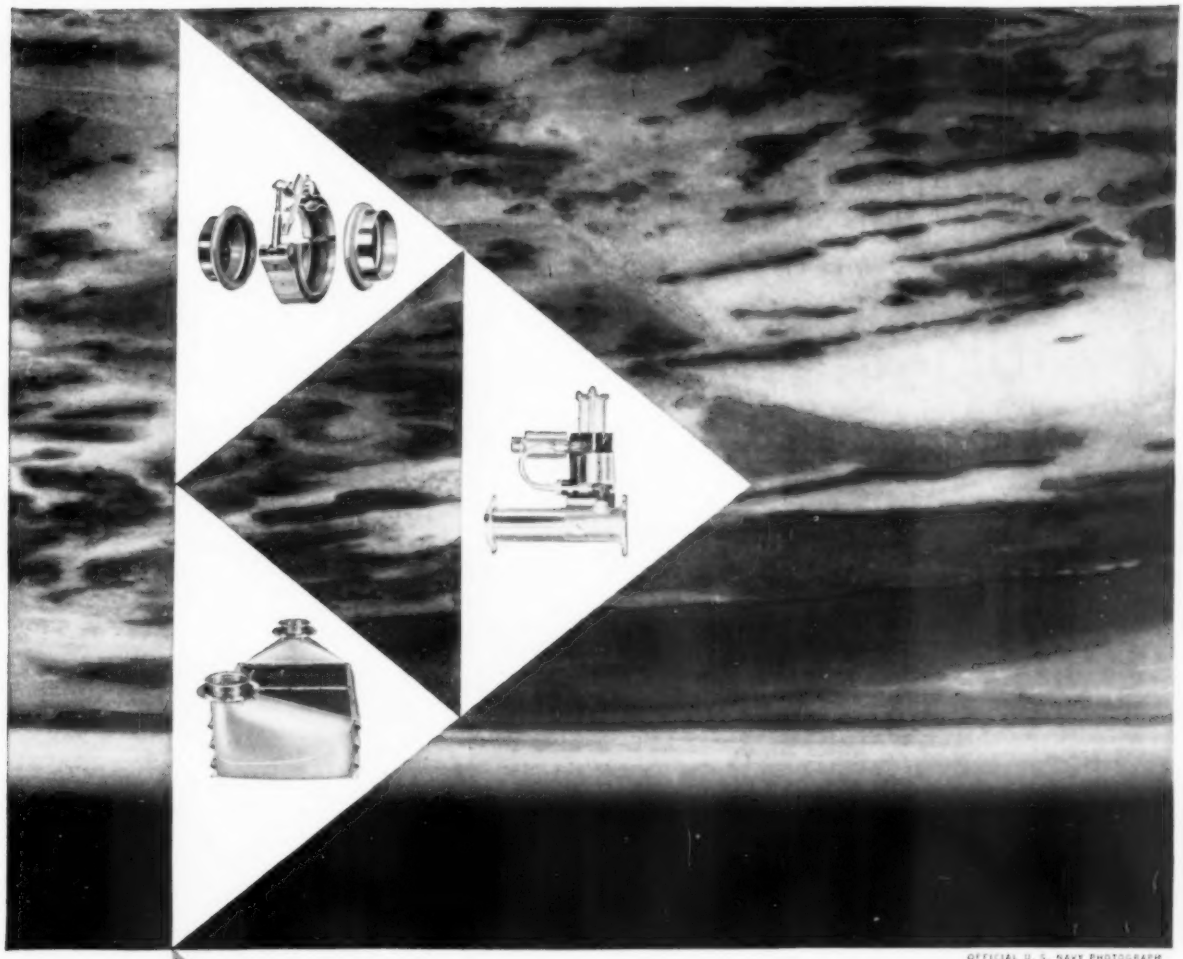
NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Export Company, New York

USS

NATIONAL SEAMLESS STEEL CYLINDERS

WALLS WITHOUT WELDS

UNITED STATES STEEL



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# three Janitrol answers to exciting new problems!

Janitrol couplings for bleed air ducts provide positive metal-to-metal seal, are easily installed in tight spots, stay pressure-tight after repeated disconnects —and in addition give lowest weight per coupling yet achieved.

Janitrol pneumatic valves and regulators bring new versatility, light weight and dependability to air distribution systems for tank pressurization, canopy seal, and other vital air-powered devices.

Janitrol Platular® heat exchangers combine the efficiency of tubes, the strength of plates, and the simplicity of modular construction. They offer new compactness, high performance, and freedom of design in restricted spaces.

If your company is making major investments in jets and missiles for the future, Janitrol's resources can serve you well. They have carried a broad range of aircraft hardware out of the design stage into proven realities. Your Janitrol representative invites your inquiry . . . Janitrol Aircraft-Automotive Division, Surface Combustion Corporation, Columbus 16, Ohio.

# EXPERIENCE IN ORDNANCE WORK

*Here are some of the Ordnance items produced by Aetna-Standard over the years...*

| | |
|---|---|
| Gun Mounts | Leveling Sockets |
| Gun Carriages | Axle Bearings |
| Howitzer Carriages | Nozzle Plugs |
| Drill Guns | Traversing Mechanisms |
| Pilot Models | Bogie Hubs |
| Breech Rings | Rocket Cases and Launchers |
| Navy Yokes | Landing Mat Machines |
| 15" H. C. Projectiles | Fork Lift Trucks |
| Shell Crimpers | Half-Track Carriages |
| Firing Mechanisms | Skysweepers |

Tank Turret Redesign

AETNA • STANDARD

THE AETNA-STANDARD ENGINEERING COMPANY

General Offices: Pittsburgh, Pa. • Plants: Ellwood City, Pa., Warren, Ohio

Research Laboratory: Akron, Ohio

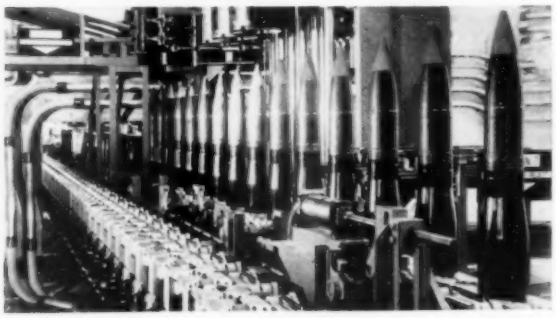
CONTINUOUS GALVANIZING LINES • CONTINUOUS ANNEALING LINES • CONTINUOUS ELECTROLYTIC TINNING LINES • SIDE TRIMMING AND SHEAR LINES AND OTHER FINISHING EQUIPMENT • CONTINUOUS BUTT WELD PIPE MILLS • SEAMLESS TUBE MILLS • DRAWBENCHES AND OTHER COLD DRAW EQUIPMENT • ROLLS AND CASTINGS • EXTRUDERS, MILLS, PRESSES FOR RUBBER, PLASTIC AND CHEMICAL




a power-generating system which can operate without outside cooling sources.

### AUTOMATIC SHELL LINE

As part of a large stand-by armament program, the Army Ordnance Department has contracted with American Machine & Foundry Company to build a fully automated shell-filling line for the Joliet Arsenal, Ill. Designed to handle either 75-



**Fully automatic shell-filling line.**

or 90-mm. shells, the system represents a "first" in the ordnance field. The complex principle of weighing the propellant and filling the shells to accuracies heretofore unknown in rapid automatic processes has been proved in equipment built and installed at the arsenal. Completion of the balance of the installation is scheduled for the near future.

The fully automated line is divided into twelve stations, all of which are monitored by a single operator sitting at a control console. In addition to elaborate instrumentation, the operator watches five television monitors that tie in with cameras focused on critical operations in the process.

### NAVY JET FIGHTER

A $100 million contract to produce a jet fighter designed to intercept enemy bombers under any weather conditions at more than twice the speed of sound has been awarded to Chance Vought Aircraft, Inc., of Dallas, Tex., by the Navy. The fighter is scheduled for flight test next summer and for delivery to the fleet by 1960.

The airplane, designed to be the first-line fighter in a new generation of all-weather Navy aircraft, could be launched from a carrier by catapult to knock down high-flying supersonic bombers in a matter of minutes.

It is being engineered to operate at altitudes which a few years ago represented record heights and will have radar and fire-control installations incorporating a number of the most advanced electronic devices being developed. Although its speed is in the range usually associated with purely experimental rocket aircraft, the new airplane will be able to land on less than 300 feet of aircraft carrier deck.

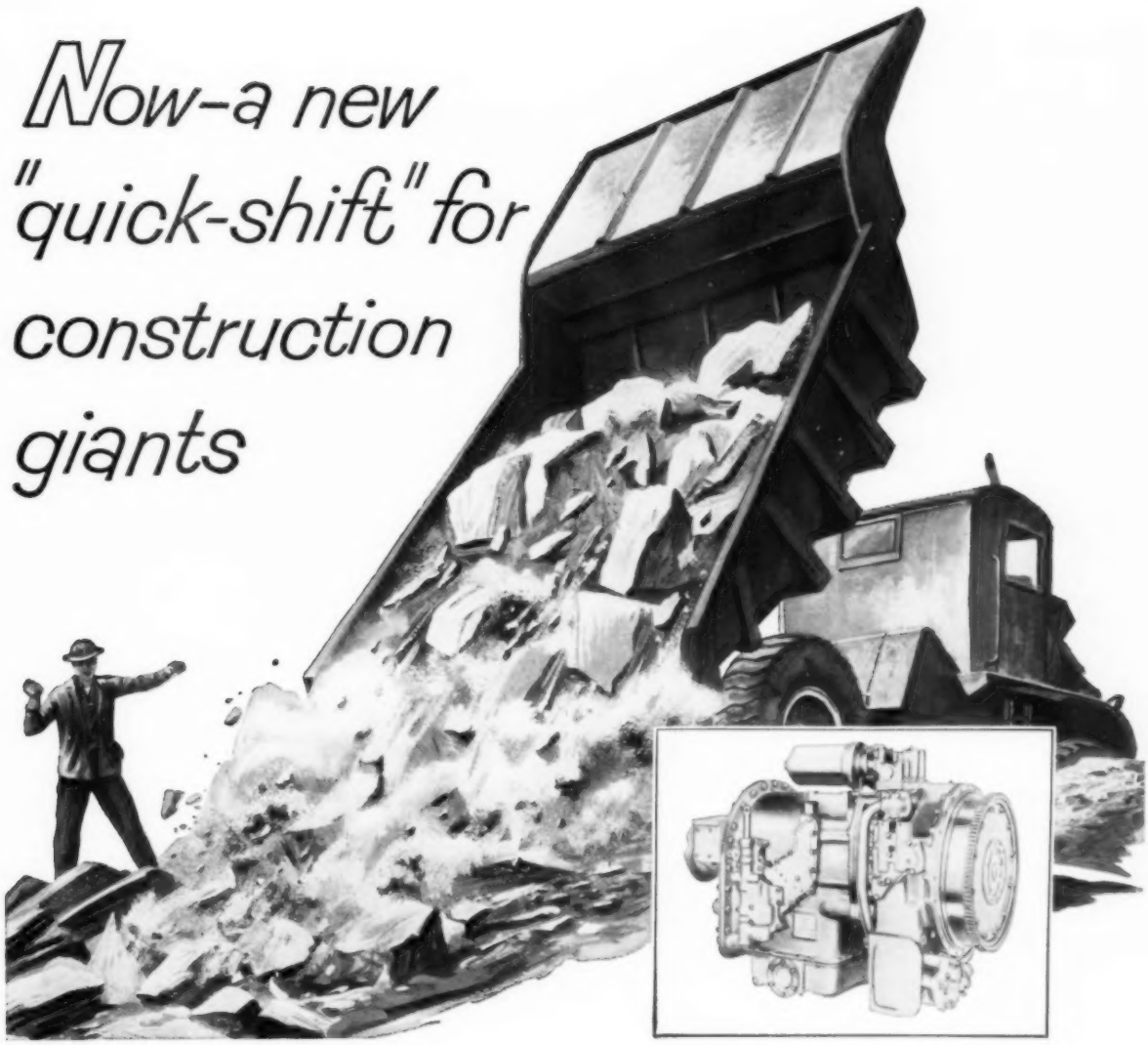
### COLLISION WARNING

An electronic collision-avoidance system that will protect even fast jet airliners from midair collisions has been developed by the International Telephone and Telegraph Corporation. The device is designed to eliminate the four "near misses" that the Civil Aëronautics Board estimates occur daily among the 140,000 aircraft flying America's skyways.

The 63-pound, self-contained equipment, which requires no coöperation from the ground or other aircraft and which utilizes weather radar for its "eyes," provides sufficient warning for airplanes approaching at almost twice the speed of sound.

With this system, four miniature antennas receive the radar impulses that have searched a 90-degree, pie-shaped sector extending from the nose of the airplane. The impulses feed an

# Now–a new "quick-shift" for construction giants



**New Allison TORQMATIC 5840 FourSpeed—the first "quick-shift" available for 400 horsepower engines.**

Here it is – available now – the Allison TORQMATIC CBT-5840 FourSpeed. This new Transmission outdates – for the first time – old-fashioned, piece-and-patch power trains in "giant" giant earthmovers, loggers and other heavy-duty construction equipment with engines up to 400 h.p. And, the new TORQMATIC CBT-5840 FourSpeed is specially designed in one compact package to provide maximum capacity in minimum space.

New high-capacity TORQMATIC Converter multiplies engine torque more than 313%–prevents engine lugging –slashes power-train and engine maintenance.

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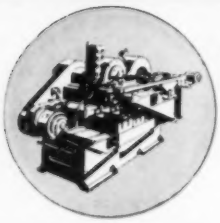
New integral Hydraulic Retarder with weight-saving aluminum impeller takes the load off your mind–permits faster, safer descents on even the steepest grades–cuts brake maintenance more than 50%.

TORQMATIC DRIVES have brought greater workability and lower operating costs to 122 different types of road-building and construction equipment made by more than 80 manufacturers. Take the tip – get the Allison TORQMATIC story. See your equipment dealer or write:

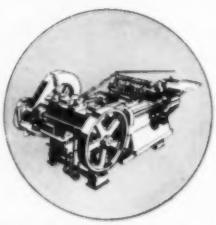
**ALLISON DIVISION OF GENERAL MOTORS, Indianapolis 6, Indiana**

**Allison** TORQMATIC® **DRIVES**

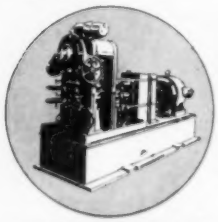
# FIVE KINDS OF MASS PRODUCTION METALWORKING MACHINERY by Waterbury Farrel



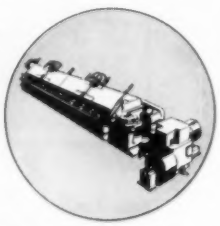
**COLD PROCESS BOLT & NUT MACHINERY** —Headers (all types) • Rivet Machinery Trimmers • Thread Rolling Machines Slotters • Nut Formers and Tappers, etc.



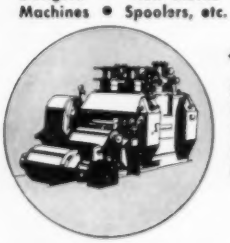
**POWER PRESSES** — Crank, Cam and Toggle; also Rack and Pinion Presses • Eyelet Machines • Multiple Plunger Presses • Horizontal and Hydraulic Presses, etc.



**MILL MACHINERY** — Rolling Mills: Strip, Rod, Tube, Wire Flattening, (For Ferrous and Non Ferrous Metals) • Also Slitters • Straighteners • Cut-off Saws • Coilers • Winders, etc.

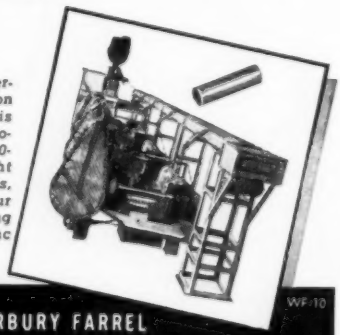


**WIRE MILL EQUIPMENT** — Continuous Wire Drawing Machines (Upright Cone and Tandem) • Wire Flattening Mills • Chain Draw Benches • Pointers • Swagers • Bull Blocks • String-up Machines • Spoolers, etc.



**SPECIAL MACHINERY** — Sendzimir Mills • Small Arm Ammunition Machines • Thread Rolling Machines For Shells • Collapsible Tube Machines • Coining Mills, etc.

*HERE'S A SAMPLE of Waterbury-Farrel mass production equipment in action. This complete WF automatic production unit combines a 40-ton double-acting, upright blanking and cupping press, a conveyor feed and four 7-station horizontal drawing presses to draw 340 zinc shells per minute.*



WF-10

WATERBURY FARREL FOUNDRY & MACHINE CO.
WATERBURY, CONN.
*Offices: Chicago, Cleveland and Millburn, N. J.*


## New Developments (Contd.)

electronic "brain" with data necessary to compute the hazard and the possibility of collision—all within two seconds. The computer determines the course to saftey designated by a red arrow or indicator. A warning horn alerts the pilot who veers the plane in the direction indicated.

### MIDGET MINE DETECTOR

A mine detector that weighs only seven pounds, one-fourth as much as current models, has been developed by the Army Engineer Research and Development Laboratories at Fort Belvoir, Va.

The detector is designed to find mines with metal parts. Big weight reductions have been made in the electronic assembly worn on the operator's cartridge belt. This unit measures 7 inches by 5 inches by 1 inch and consists of 4 hermetically sealed plug-in subassemblies.

Repairs involve merely replacing one or more of these compact, plug-in units with a spare.

### ION ENGINE

A useful ion rocket engine can be built and operated, according to C. W. Guy, assistant general manager of Rocketdyne, a division of North American Aviation, Inc. Such an engine—developing thrust through the high velocity discharge of ionized particles—would make possible unmanned space vehicles capable of sustained flight and directed orbits about any planet in the solar system.

An ion-propelled vehicle nicknamed "Snooper" already has been suggested which would carry television, radar, and other scientific instruments to send information back to earth. Such an ion-propelled vehicle could ride to the fringe of space in the nose of a rocket—possibly through "the modification of one of our larger existing vehicles." Once there, winglike radiators for discharging excess heat would unfold, and its nuclear-powered, low-thrust ion motor would begin operation. The initial nuclear fuel charge would allow the Snooper vehicle to operate effectively for about a year.

### RECONNAISSANCE POD

A multimillion dollar production phase on the company-designed reconnaissance system pod for the B-58 Hustler has been initiated by a contract received by Fairchild Camera and Instrument Corporation from Convair Division of General Dynamics, prime contractor for the supersonic bomber.

This is the first time a photographic reconnaissance system has been designed and built under the "weapons system" concept in which each weapon is planned as a complete system with every related part designed in harmony with its neighbors under the over-all supervision of a prime contractor.

In the pod, closed-circuit television is employed for the first time in a photo-reconnaissance system. A TV camera in the nose of the pod gives the photographer-navigator a "window" on his control panel which enables him to view terrain and select targets for photography if desired. Each photo taken by the system, which contains seven precision aërial cameras, is automatically indexed so that each individual negative has printed upon it all the pertinent data required by an intelligence agency's photo interpreters. Best shutter speeds and lens openings for all cameras in the system are automatically selected for each exposure. Film speed is coördinated with aircraft motion to eliminate all blur.

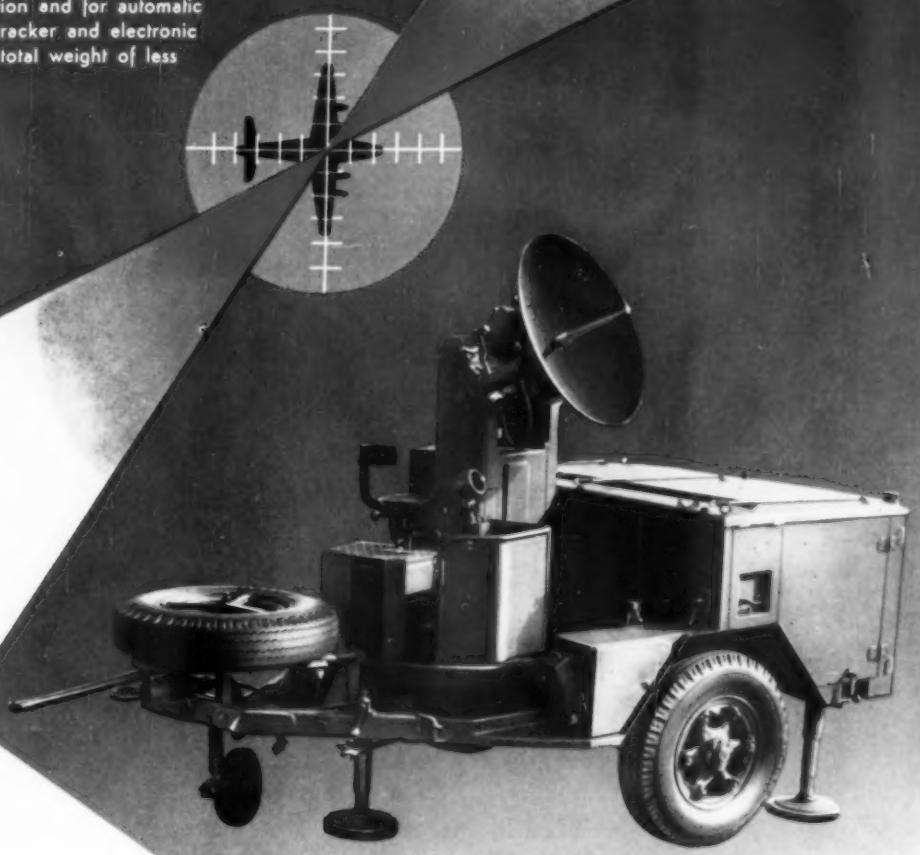
### PERSHING MISSILE

The Army has named its newly planned solid-propellant missile after Gen. John J. Pershing. The new missile, which will soon be under development, will succeed the Army's Redstone. While retaining Redstone's mobility, field worthiness, and accuracy, the Pershing will be smaller, lighter, and even more mobile for quick land and air transport.

GUN FIRE CONTROL SYSTEMS FOR MEDIUM A.A.A. BATTERIES

The picture shows a Gun Fire Control System for 40 m/m Guns

consisting of: Fire Control Radar Set for target acquisition and for automatic tracking, optical tracker and electronic computer with a total weight of less than 3 tons.

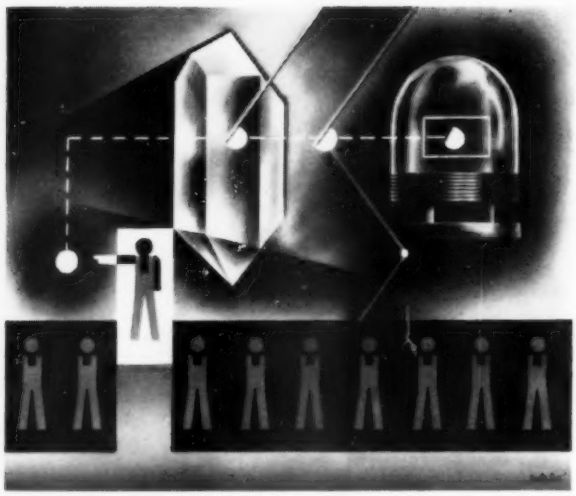


Simplified operation
High mobility and quick emplacement
Quick computation of gun data with maximun accuracy / Training of maintenance personnel has been simplified considerably through the application, wherever possible, of techniques and components similar to those employed in the design of the Contraves F/90 Director.

CARETTO

# CONTRAVES ITALIANA S.p.A. ROMA

**MISSILE COMPONENTS** Bulova's infra-red seeker cell—the Sidewinder's eye — locks this missile on target; Bulova fuzing systems do the rest. Powder-driven gyros, timers, safety-and-arming systems and other electronic and electro-mechanical devices, designed and made by Bulova, play vital roles in the Dart, Talos, Sparrow... in all, 18 key missiles.



**AUTOMATION** Bulova R&D designed mechanized plant and equipment for Signal Corps goal of 10,000 perfect quartz crystals per 8 hour shift —with 1/10th the manpower. From systems analysis through equipment development, Bulova engineers devise industrial and military facilities for automatic production of electronic components and ordnance items.

# Bulova precision helps to solve today's most challenging problems

Time, mass, length... the age-old concepts man relies on as he enters the Age of Space.

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Bulova, leader in measurement of time, has become master of the very combination of abilities that holds practical solutions to the growing challenges of miniaturization.

Miniaturized systems and components by Bulova are now working for our nation's defense and automated industry. The same vision and experience that developed them are available to assist you... from concept to reliable mass production.

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**AIRCRAFT INSTRUMENTS** Bulova's new Servo Altimeter combines unsurpassed sensitivity and accuracy with direct-reading tape presentation. Special pressure devices created by Bulova include transducers for air data computers... remote pressure sensors for weather stations and airports... climb and dive indicators... and autopilot altitude controls.

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# MATERIALS PROGRESS

George S. Brady

**Aluminum Production.**—Although the aluminum smelters have not been operating up to capacity, and there have been some surpluses of metal on the market, all the producers are planning increases in capacity. This optimism is being expressed even in the face of an awareness that newer types of superspeed aircraft will take proportionally less aluminum than previous designs, and it reflects a strong belief in the broadening usage of aluminum as a structural material.

Total rated capacity of all aluminum smelters in the United States at the end of 1957 was 1,888,000 tons of basic metal annually. *Alcoa*, the largest producer, will add 20,000 tons' capacity at its Point Comfort, Tex., plant, bringing the company's capacity well above the million-ton mark. *Aluminum Company of Canada* produced only 619,000 tons of primary aluminum in 1956 with a rated capacity for 762,000 tons, but increases now being undertaken will bring capacity to 1,032,000 tons by the end of this year or soon after. Increases in capacity by other companies are equally optimistic.

Producers have repeatedly stated that they do not want to assume positions as manufacturers of end products, but they are continually probing new markets to demonstrate the possibilities of the metal. As one example, last spring Alcoa introduced a new lightweight farm gate in 10- to 16-foot lengths, 52 inches high, made from riveted aluminum channels, complete with hinges, screw hooks, and latch chains of aluminum. More than 10,000 were sold during the season.

Of the 460,000 small pleasure and fishing boats sold in the past year, 33 per cent were aluminum. Low-cost maintenance, with no necessity for painting, was one of the sales points. It is estimated that only about 30 pounds of aluminum was used in 1957 in the average new residential house, but some credible estimates of builders indicate that the average will exceed 1,000 pounds per house unit by 1965, the forecasts being based on the expanding use of aluminum for windows, doors, hardware, gutters, and piping. In business and factory buildings the increase will also be great. The new Hilton Hotel in Pittsburgh will have 150 tons of aluminum in its exterior panels, and the window frames and column covers will be of gold-anodized aluminum.

The new highway program, which contemplates a building rate of 3,000 miles of superhighways a year, is taking aluminum for signs, railings, chain-link fencing, and bridge elements. Some 500 tons of aluminum were used in the new Walt Whitman bridge at Philadelphia for railings, traffic-light spans, catwalks, and lighting standards. An idea of the maintenance savings possible can be seen from the fact that more than 20,000 gallons of paint are required for the George Washington bridge every two years.

**Aluminum Containers.**—Probably the largest basic impact on aluminum, and one which will have an important effect on imported tin, is likely to come soon from developments now going on in the can-making industry. More than 3.5 million tons of steel have been used annually for making cans. The can market has been expanding, and it is stated that if only half of the cans are produced in aluminum it would take 1,000,000 tons of that metal annually.

The effect on tin could be even more startling. Tin was a major supply problem during World War II when, in spite of the savings from the introduction of electrolytic plate, 48 per cent of all new tin was going into tinplate and another large amount of tin was being used in solder for seaming cans.

The process for producing aluminum monobloc cans with integral bottoms was first commercialized in Italy, and all of the aërosol-type containers now made in that country are of aluminum. Tops may be crimped on, but the smooth sides of the can make it easy to produce flanged-over tops with pressed-in closures. In this country, also, research has been done on various types of resin sealers. The first large contract in the United States was for a minimum of 35 million quart oil cans for *Esso Standard* to be made by the *American Can Company* and the *Crown Cork & Seal Company*. These cans weigh 2 ounces compared with 4 ounces for steel cans. *Reynolds Metals* produced the plate.

For packaging grated cheese, *Kraft Foods* ordered 5 million aluminum cans from *Kaiser Aluminum & Chemical Sales, Inc.* The cans have an internal diameter of 1.89 inches and a height of 5 11/16 inches, and have a body wall thickness of 0.009-inch. They are flanged on top for a pressed-in closure knurled for easy opening.

In general, the deep-drawn cans produced in one stroke from flat disks have a high polish that needs no further finishing, and proponents are enthusiastic about the possibilities of direct printing and of anodized finishes in colors. At present, the aluminum can is merely nibbling the edges of the can market, although tests have indicated that many wet foods can be stored in contact with aluminum without injury. Steel, on the other hand, is fighting to retain an important part of the market, with new chromated and resin-coated cans.

**Electrical Conductors.**—Aluminum is also digging into what has hitherto been the best market for copper, namely, in electrical conductors. *Alcoa* recently has announced that new techniques have made it possible to furnish all aluminum redraw rod and conductor wire with a minimum electrical conductivity of 62 per cent without reduction in tensile strength. *Kaiser* is now producing flat aluminum wire with rounded edges for magnets and for transformer and commutator windings. It comes in a variety of sizes, with thicknesses from 0.020- to 0.187-inch and in widths from 0.063- to 1 inch.

**Crucible Lining.**—A process has been developed in England for lining graphite crucibles for the melting of titanium to eliminate the pick-up of carbon in the molten metal. Columbium foil with hafnium carbide sintered on one side is inserted as a lining in the crucible. When molten titanium at a temperature of about 1,750 degrees centigrade is poured in, the foil is sintered to the graphite, forming a permanent tight coating of refractory columbium-hafnium carbide.

**High-purity Columbium.**—Several companies are now producing high-purity columbium for high-temperature alloys and for special uses of this increasingly important metal. The *Westinghouse*

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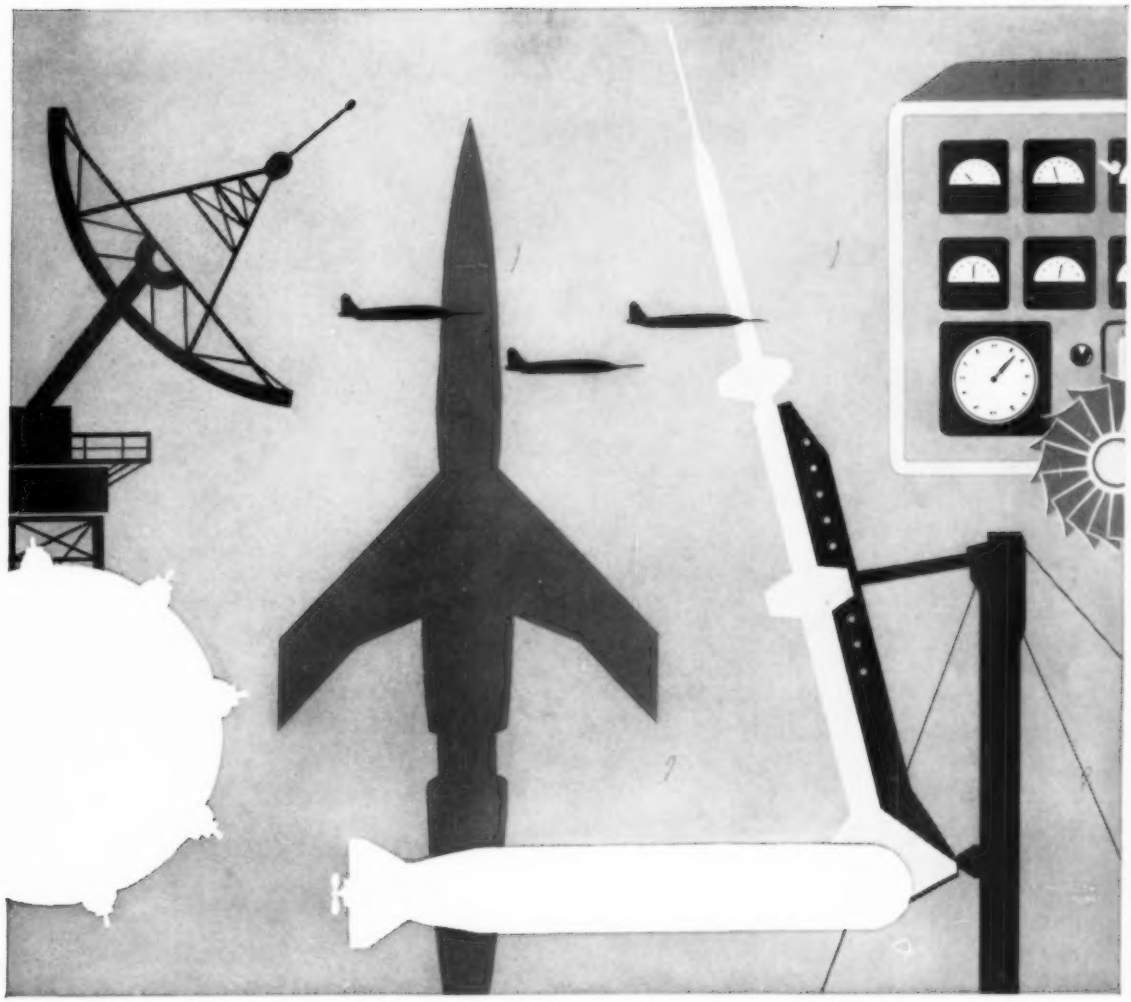
*Colonel Brady is a consulting engineer, author, and editor, Washington, D. C. He is a well-known authority in the field of materials, and his "Materials Handbook" is a recognized source of information on the subject.*



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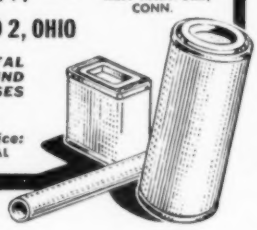



## Materials Progress (Contd.)

method consists in refining under vacuum at a temperature of about 4,400 degrees Fahrenheit, removing all trace impurities.

Development work is also going on for the chemical extraction of columbium from hitherto unusable ores in the United States and Canada. These include the euxenite of Idaho, which is high in columbium-tantalum, and the black sand occurring with the bauxite of Arkansas which contains 0.08 per cent columbium. Metal oxide of 99.5 per cent purity has been extracted chemically from the complex mineral pyrochlore which is plentiful in Canada.

**Chemical Ore Extraction.**—Chemical extraction of ores is one of the most important developments forecast for the immediate future. In the past, cost has been the impediment to chemical extraction, and it has been realized that a great amount of costly research would be necessary before economic commercial methods might be in sight. Probably the greatest spur to chemical and electrochemical research has been through the development work on uranium and other rare metals now necessary for the new age.

The cutback in AEC contracts for delivery of uranium ores has been interpreted as merely an attempt to call a halt to the wild spree in mining stock offerings, and it is not expected to interfere with the progress of technical research. Uranium ores contain less than 0.3 per cent $U_3O_8$, making it impractical to upgrade by physical methods and also impractical to use metallurgical methods of extraction. The same is true for the extraction of zirconium and hafnium from the zircon sand of Florida. The ultimate pay-off that will benefit the whole economy will be found in the fact that chemical methods lend themselves readily to continuous flow processes, and we may expect that eventually all types of low-grade and complex ores can be put into solution and all the component metals extracted economically.

**Use of Beryllium.**—Beryllium is a metal that needs more basic research attention. The Government has been stockpiling beryl, but the answer to the supply position does not lie in that direction. As long as dependence is placed upon beryl, the metal will remain scarce and expensive.

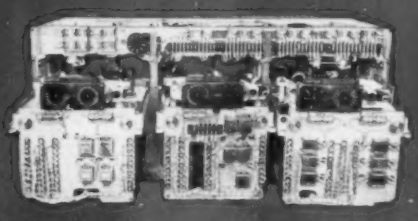
Actually, the metal is widely dispersed in nature and quite plentiful, but no economic method has yet been developed to extract it from other ores. With its specific gravity of 1.84, it has only about two-thirds the weight of aluminum, but has greater strength, a high stiffness-weight

# A bird in hand...

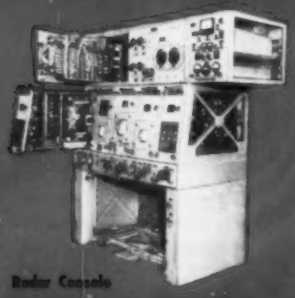
## RADAR INTELLIGENCE FOR ALL APPLICATIONS

*Produced at*

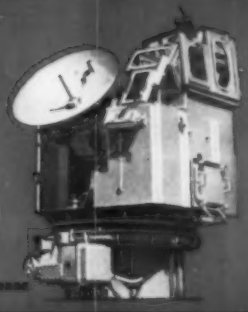
**DAYSTROM INSTRUMENT**



Fire Control Computer



Radar Console



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## Materials Progress (Contd.)

ratio, a much higher melting point, and a high strength modulus at elevated temperatures. It is ideal as a construction material in aircraft and missiles, but with a cost of around $47 a pound for the crude metal little attention has been given to this use. It is a reflector of neutrons, and the AEC has been using it for this purpose.

Most of the attention has been directed to its use for hardening copper alloys and for tiny additions to aluminum and magnesium alloys to refine the grain and improve heat stability. The Air Force has given a development contract to the *Brush Beryllium Corporation* to produce sheet for superspeed aircraft. The process will be to use pressed-powder sintered slabs and roll into sheets from 0.020- to 0.060-inch thick. But commercial sheet and shapes have been costing up to $100 a pound, and all indications point to the necessity for better extraction methods before the metal will be available for construction purposes.

**Synthetic Rubber.**—Possible loss of the entire supply of rubber from Indonesia because of the tense situation there is no longer a problem. United States consumption of new rubber in 1957 was 1,475,000 long tons, but 934,000 tons, or more than 63 per cent, was synthetic rubber, and research has now reached a point where it is evident that polyisoprene artificial "natural" rubber can replace natural rubber for practically all important uses.

New butyl rubber truck tires made for military vehicles have shown superior wear and heat resistance, and recent tests have indicated that mileage can be increased almost twofold with urethane casings. A still newer development with fluorosilicone rubber and wire cord indicates that tires which will give outstanding wear and oxidation resistance and will withstand sustained temperatures to 500 degrees Fahrenheit can be expected. Natural rubber is definitely no longer a strategic material.

**Versatile Plastics.**—Plastic shell cases (155-mm.), injection-molded for the Navy, have been reported as giving good results in withstanding firing pressures. The material used is a high-impact styrene copolymer. The weight is only half that of a metal shell case, and it is lower in cost and easier to manufacture than either brass or steel shell cases.

Society of the Plastics Industry reports that plastics production in 1957 was 2,150,000 tons, not including the 1.75 billion pounds used in synthetic fibers. This represents an increase of about 10 per cent over 1956. Increased use is evidenced in all types of products, but the expanding use for piping is notable. A new 30-mile pipeline to carry ethylene from Lake Charles, La., to Orange, Tex., is of 6 5/8-inch ethylene plastic pipe.

A representative factory installation is at the food-processing plant of the *H. W. Madison Company*, Medina, Ohio, where polyvinyl chloride pipe and fittings are used to carry vinegar, salt brine, and other corrosive liquids at temperatures not exceeding 160 degrees Fahrenheit. The plastic piping gives higher flow rates, less clogging, and lower-cost maintenance than the stainless steel formerly used.

In line with the idea of getting away from the use of scarce and expensive strategic metals is a new Y valve of the *Corning Glass Works*, designed for handling all acids except hydrofluoric and concentrated phosphoric. The material used is a tempered low-expansion borosilicate reënforced with an armor of fiberglass-filled polyester resin. The 2-inch valve weighs 9 pounds, is good for a maximum line pressure of 50 pounds per square inch, and will withstand sudden temperature changes of 200 degrees.

Along the same lines, the *Walworth Company* has a plastic strainer for pipe sizes from ½ to 2 inches made entirely of polyvinyl chloride and good for pressures of 150 pounds per square inch at 75 degrees Fahrenheit, or 75 pounds at 150 degrees. The strainer unit itself, with a cross-section area twice that of the pipe size, is of rigid PVC sheet in tubular form, easily cleaned by unscrewing.

**Titanium Plating.**—*Horizons, Inc.*, has developed a process for titanium plating that gives smooth, nonporous coatings on steel so that the benefits of the corrosion resistance of the metal can be had without the cost of solid titanium. A fused bath of oxygen-free potassium-titanium-fluoride in sodium chloride is used as the electrolyte with inert graphite anodes, and at a voltage of 5.7 the titanium ions migrate to the cathode. The fusing point of the electrolyte is 1,330 degrees Fahrenheit, but a minimum temperature of 1,470 degrees is necessary to diffuse the titanium in the base metal and make a good bond. A peculiarity of the plating process is that the coating forms a crystalline deposit, after building up to a thickness of about 0.0016-inch, which must be washed off and the cycle repeated.

**Thermionic Converter.**—A new thermionic converter now under development at the *General Electric Company* laboratories may be the beginning of something useful for converting the great amount of waste heat of atomic power plants directly into electrical energy. In general, it consists of two molybdenum electrodes in a tube containing a gas that has positive ions. The two electrodes are maintained at different high temperatures (2,500 and 1,250 degrees Fahrenheit), and one metal electrode emits electrons which are collected on the other.

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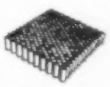
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# ARMAMENT ELECTRONICS

**W. H. Van Vliet**

**Ultraprecise Compass.**—The new Douglas DC-8 jet airliner will use a new ultraprecise compass system recently developed by the Sperry Gyroscope Company. The new system will allow the navigation of the giant jet airliner to be held within unprecedented limits. The Sperry C-11 compass system affords random gyro drift rates as low as one-half degree per hour. Gyro systems in general use today drift from three to eight degrees hourly. This extremely accurate compass system will allow air crews to navigate precisely over areas where ground navigation aids are limited and at high latitudes where magnetic compasses are unreliable.

**Scatter Balloons.**—The Army's Electronic Proving Ground at Fort Huachuca, Ariz., is evaluating an air-transportable tropospheric scatter communications system which uses an air-inflated plastic antenna reflector fifteen feet in diameter. The entire system, developed by Collins Radio, can be air-packed in two metal huts for transport in C-124 or C-119 aircraft. The huts are used as operating shelters when the system is installed. The equipment will operate in the 1,000-megacycle region, and provide multichannel operation in the midrange area of about 50 to 150 miles.

**Army Navaid.**—The Army Electronics Proving Ground, Fort Huachuca, Ariz., will soon flight test a lightweight, versatile electronic navigator for the Army's aviation effort. The new system, developed by Ryan Aeronautical Corporation, weighs one hundred pounds, and provides drift angle, ground speed, latitude and longitude, and automatically computes distance and course to a preset destination. No ground facilities are required.

**Polaris.**—Lockheed Aircraft Corporation recently received a $62.1 million contract from the Navy for Polaris. The electronic portion of Polaris going to other activities is substantial. Westinghouse has received a $10 million contract for launching equipment. Sperry will supply the inertial launching system for the U.S.S. COMPASS ISLAND, and General Electric has $1.5 million contract for guidance.

**Reliability Test.**—The Office of Assistant Secretary of Defense for Research and Engineering has established a program to use new test and design procedures for the purpose of improving reliability. These procedures will be tried by the three services on new equipment and development programs. These latter programs will serve as test cases to determine the efficacy of the procedures recommended by James M. Bridges, Director of Electronics, Office of Assistant Secretary of Defense for Research and Engineering.

**Radio Telescope.**—The Office of Naval Research is sponsoring a radio telescope, 85 feet in diameter—the largest of its kind in the United States—to be installed near the University of Michigan campus at Ann Arbor. The dish, which is of parabolic shape, will employ equatorial mounting with its axis aligned with the celestial north pole and can be rotated east and west to compensate for the earth's rotation. The parabola also can be rotated about 140 degrees in elevation. The instrument is being designed and installed by Blaw-Knox Company.

**Semiconductor Standards.**—The Electronics Industries Association is setting up a semiconductor industry facility at Syracuse University to standardize methods and techniques to measure critical diode and transistor characteristics. The new laboratory uses as a pattern the procedures used by RCA for the vacuum-tube industry. Alternate-source semiconductors will be tested by Syracuse University to determine whether they have the same characteristics as primary-source diodes and transistors.

**High-power Radar.**—The Army Ordnance Corps through a contract with Cornell Aeronautical Laboratory has developed microwave radar signals with peak power of 17 million watts. This has been accomplished by means of a new micro-

*Lieutenant Colonel Van Vliet, formerly director of armament electronics, Northeast Air Command, and formerly chief of the Operations Division, Air Force Ammunition Services, is engineering representative of International Engineering Electronics, Inc., Washington, D. C.*

wave generator. Cornell announced that average power is higher than that previously obtainable. No information on duty cycle or pulse length was released. This system would have value in some methods of missile tracking at long ranges.

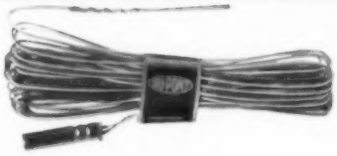
**Lightweight Tube.**—RCA's Electron Tube Division in Harrison, N. J., will soon have a traveling wave tube available which only weighs half a pound. The new tube requires no focusing magnet and delivers 2 watts of power in the S-band region. It differs considerably from earlier experimental electrostatically focused tubes in that it requires only one pair of helices for focusing. This simplified construction should improve reliability and cut manufacturing costs. Sample quantities will be available shortly for experimental purposes.

**Small Business.**—A recent survey reveals that almost two-thirds of all electronics businesses are "small business" according to the definition established by Government procurement agencies. Small business is an activity that employs less than 500 and is not dominant in its field. Only one-quarter of the electronics industry falls under the big-business category of 1,000 employees or more. Medium industry employing an average of 700 persons represents only 8.5 per cent of the total.

**TV Radar.**—A low-cost ship's navigational aid for use in harbors has been announced recently by Italian authorities. A shore-based TV transmitter broadcasts a radar pattern of the harbor. The incoming vessel's pilot can see the plan of the entire harbor with his ship represented by a pip. He can thus maneuver by watching the pip in any kind of weather. This system, covered by Italian patents, will be a boon to small vessel operators.

**Ion Engine.**—Rocketdyne division of North American Aviation, Inc., states that a useful ion rocket engine can be built and operated. This type of engine obtains thrust by means of high-velocity discharge of ionized particles. Such an engine would allow sustained flight of unmanned space vehicles.

**Airborne Computer.**—Ramo-Wooldridge recently has developed a lightweight digital computer for Westinghouse. The RW-30, a completely transistorized device, provides computations for bombing, navigation, and fire control. It weighs a little over 200 pounds and can perform about 4,000 arithmetical computations a second.



The Martin USAF B-57 tactical bomber carries wing-tip fuel tanks to increase its range. When the fuel in them is exhausted, the tanks are jettisoned by actuating explosive bolts with Du Pont electric detonators (left).

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On still another model, a mechanical "hand" actuated by a Du Pont Detonator "snatches" the control column forward under the instrument panel. This protects the pilot's legs from injury as he is shot out of the plane to safety.

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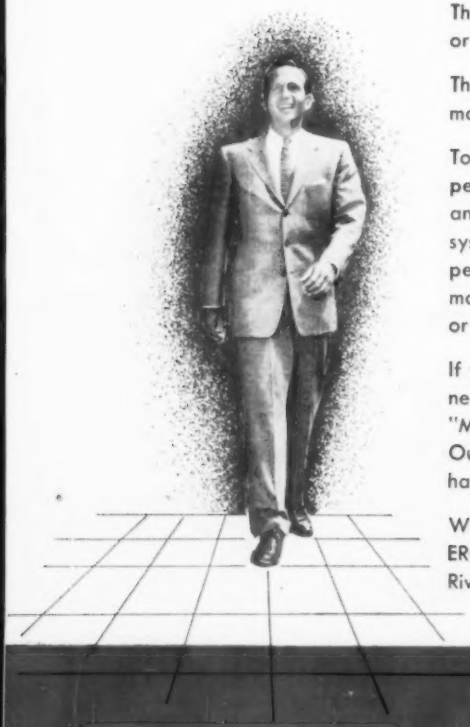

The guidance system of a missle is critical to its purpose—without the system—or without intelligent handling of the system's equipment there is no effective weapon.

The military must train its "unskilled short-term" personnel to operate and maintain this system—and the question arises . . . How?

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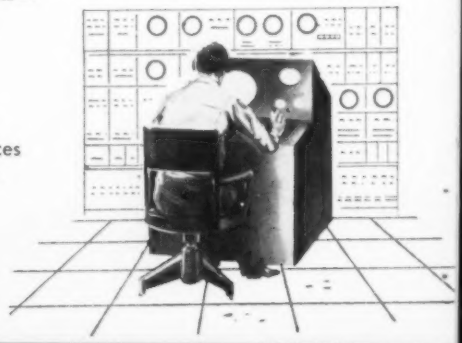

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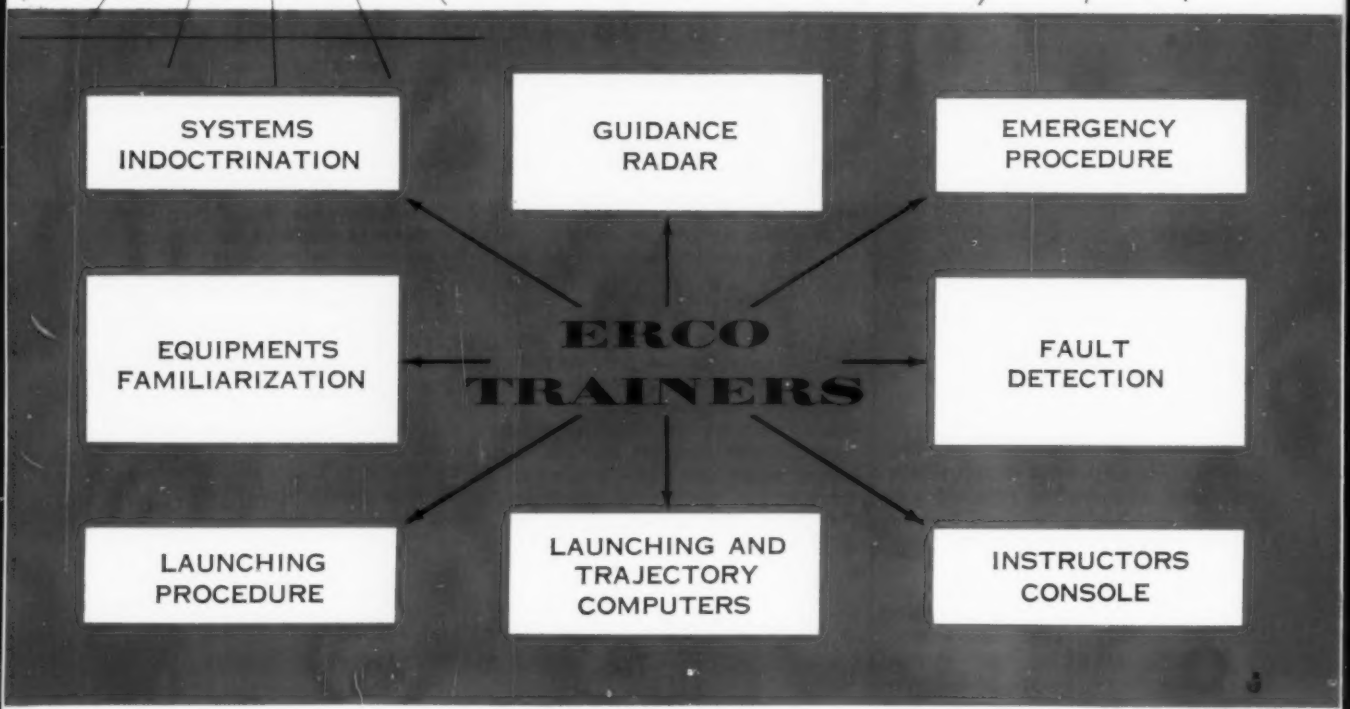


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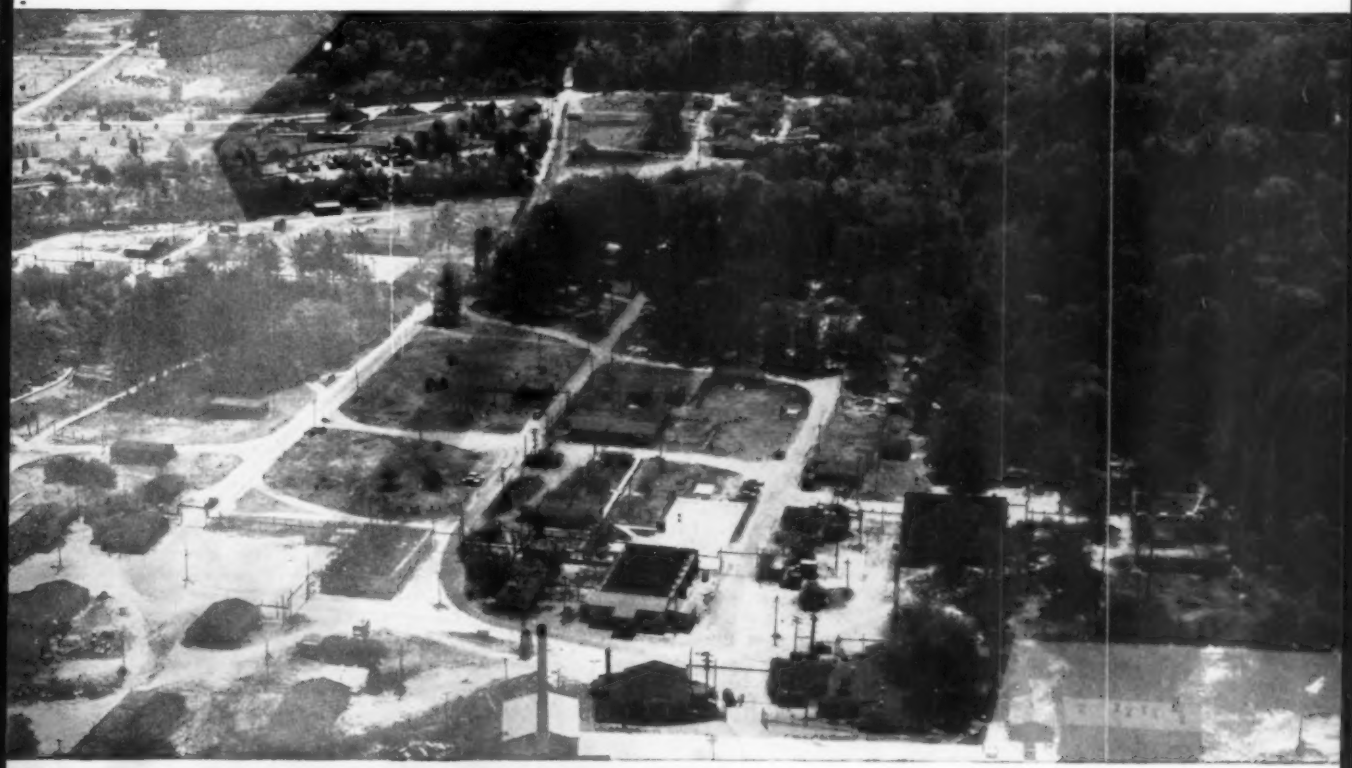

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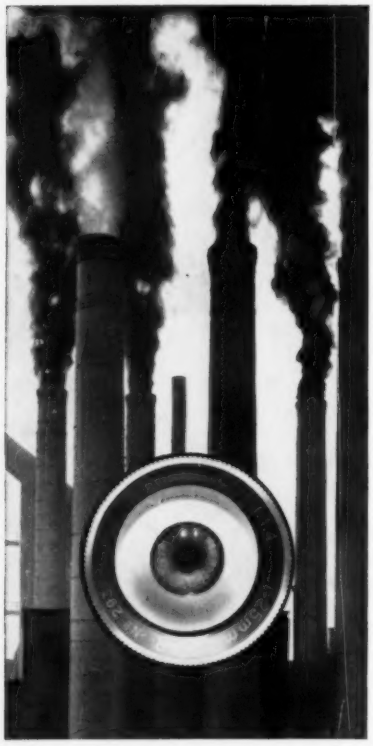

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# ROCKETS AND GUIDED MISSILES

ALFRED J. ZAEHRINGER

**Astronautics.**—After the failure of the first Vanguard satellite attempt in December, the Army was given the go-ahead to conduct a moon-making program. Difficulties in the second Vanguard attempt in January opened the road for an early Army attempt. The Army used a *Jupiter-C* vehicle. Rigged from existing hardware, the *Jupiter-C* consists of a modified Redstone missile as first stage, a bank of eleven "scaled-down" Sergeant-type solid-propellant rockets as the second stage, and three similar solid rockets as the third stage. The fourth stage includes the satellite and a single small rocket.

The entire vehicle is about 70 feet long and has a maximum diameter of about 5½ feet. A guidance package also is included as payload. The actual satellite is a 29.7-pound cylinder, 2 feet long and 6 inches in diameter, supplied by the Jet Propulsion Laboratory.

In recent Senate hearings, Maj. Gen. B. A. Schriever, Commander, Ballistic Missile Division, Air Research and Development Command, revealed that by 1959 the Air Force is planning on an unmanned satellite which could be recovered. Moreover, the Air Force wants to divert about eighteen *Thor* IRBM's for a space flight program. Such Air Force astronautical ventures would include a moon impact and unmanned reconnaissance of the moon, Mars, and Venus.

The U.S.A.F. Ballistic Missile Division also suggested that the *Titan* ICBM rocket engine could be used to establish manned satellites and provide for manned trips to the moon and return.

Another space venture will be the firing of four *Redstone* missiles to study above-atmosphere atomic bomb bursts. The missiles would carry the nuclear devices to 250,000 feet and beyond above Eniwetok. The atomic blasts would be used to gather information on detonations under near space conditions. Lack of air would decrease blast effects and change radiation patterns.

Meanwhile, NACA has formed a Special Committee on Space Technology to coördinate that group's space-flight efforts. The committee will be headed by Dr. H. Guyford Stever, formerly chief scientist with the Air Force.

**Missiles.**—Both of America's 1,500-mile-range IRBM's—the *Jupiter* and *Thor*—will be placed into production. IRBM deployment is expected by 1959 at British bases.

The Army Ordnance *Jupiter* will be produced by the Chrysler Corporation at its Warren, Mich., plant. The same plant will continue to produce *Redstone* missiles. *Jupiter* is about 65 feet long and has a diameter of about 7 feet. Guidance is an inertial system developed by Ford Instrument. Thrust of the liquid oxygen rocket engine—produced by North American Aviation—is about 165,000 pounds. Unit cost of the missile is about a million dollars.

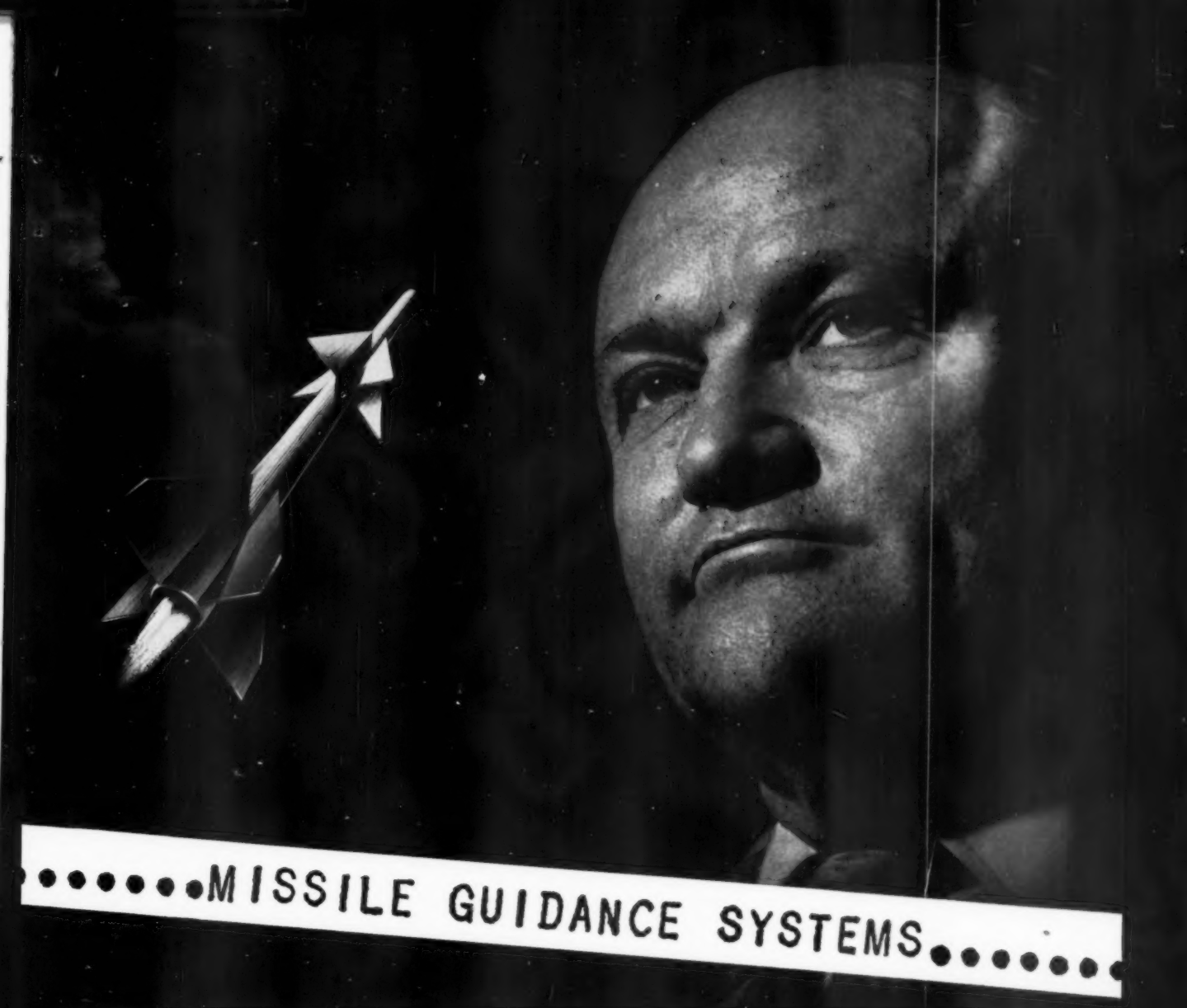
The Air Force *Thor* is to be produced by Douglas Aircraft at Culver City, Calif. The missile is powered by the same engine that powers *Jupiter*. Guidance for *Thor* is of an inertial-type built by AC Spark Plug.

Recent successful *Atlas* firings in Florida have outlined its general configuration (see photo on page 796). The *Atlas* ICBM is about 85 feet long and has a diameter of about 10 feet. Launching weight is on the order of 90 tons. Boost for *Atlas* comes from two liquid-oxygen rocket engines of 165,000 pounds' thrust each. These boosters are the same as those powering *Jupiter* and *Thor*. Sustainer for the ICBM is a 65,000-pound-thrust rocket (which may be the same as the *Redstone* engine). The Convair-built missile has a characteristic blunt nose cone, a 9-foot-long corrugated-skin warhead section, and two external guidance packages.

Success on the submarine-launched *Polaris* 1,500-mile missile has resulted in a $47 to $50 million increase for 1958. The Navy missile, designed to be launched from a submerged atomic-powered sub, is a solid-propellant rocket by Aerojet-General Corporation. Lockheed Aircraft Corporation is acting as systems manager. The high-acceleration-take-off missile is reported to be multistaged and about 50 feet long.

A first view has been given of the atom-armed, MB-1 *Genie* air-to-air missile. The solid-propellant weapon has a diameter of about 12 to 15 inches and is some 9½ feet long. This Air Force rocket

*Mr. Zaehringer, president of the American Rocket Company, Wyandotte, Mich., is a recognized authority on astronautics, guided missiles, and jet propulsion.*



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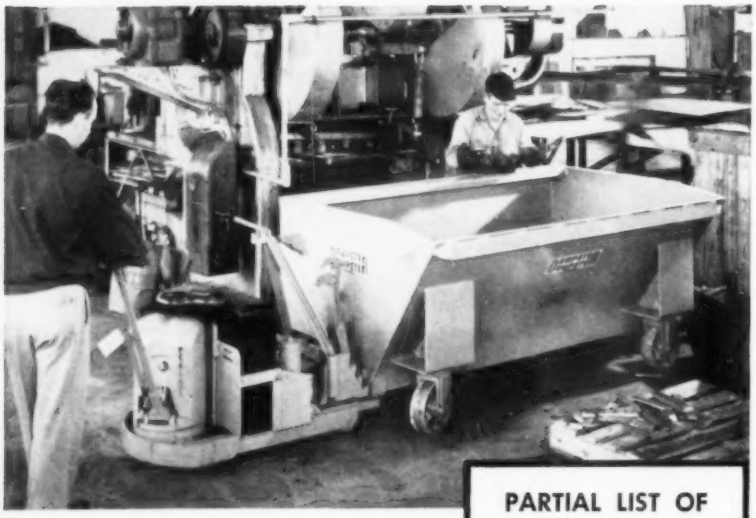

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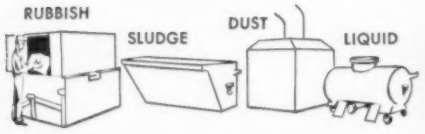


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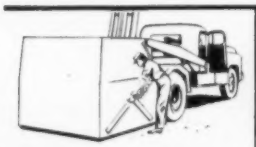
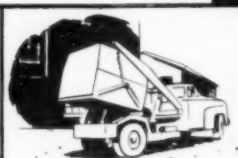
THE DEMPSTER DUMPSTER SYSTEM



CONTAINERIZED WASTE IS PICKED UP . . .



HAULED . . .

. . . AND DUMPED




has been carried on the F-89J and the F-101B.

An antimissile missile system is shaping up. The Army and Air Force are to share responsibility for developing and producing such a system. The Air Force will be responsible for detection and tracking radar systems while the Army will be vested with the missile system. It has been stated that the *Nike Zeus*, a solid-propellant rocket with a range of several hundred miles, will be the missile to protect America from ICBM attacks.

**Propulsion.**—Next step beyond the chemical propellants of today and tomorrow such as liquid oxygen, fluorine, or ozone, may come from free radicals. Free radicals are fragments of chemical molecules. Mere recombination results in tremendous energies being liberated—some two to ten times greater than the combustion of the best possible chemical fuels.

The Defense Department has assigned the National Bureau of Standards as the center for a government-university-industry research team devoted to the production and stabilization of free radicals. Best free-radical performance would come from the recombination of hydrogen atoms to form ordinary diatomic molecules. Some 92,000 Btu per pound are liberated which would result in a specific impulse of over 2,100 seconds in a rocket.

Present liquid-oxygen propellants give only about 250 seconds. The exotic boron fuels yield only about 30,000 Btu per pound while conventional hydrocarbons such as gasoline give only 18,000 Btu. The combustion of molecular hydrogen gives about 52,000 Btu and is the most energetic chemical fuel. Free radicals, because of their high heat content, would make for more compact vehicles.

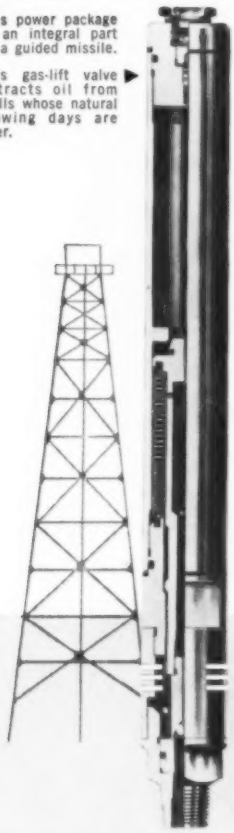
Closer to taming is the atomic rocket. The Atomic Energy Commission has awarded a multimillion dollar contract for construction of a static test facility to handle an atomic rocket which may be slated for late 1958. The test site is at the Nevada Proving Grounds. It is not certain what form the atomic rocket motor will take, but conjectures are that it will take the form of an atomic pile which heats up a working fluid, such as hydrogen, to high temperatures and ejects it through a conventional rocket nozzle.

Both North American Aviation and Convair engineers have given a view of what they think an atomic rocket can do. North American figures that a pile diameter of about 3 feet (with a temperature of about 4,000 degrees Fahrenheit) would produce a thrust of 100,000 pounds with hydrogen. Specific impulse of such a system would be near 800 seconds—nearly four times better than conventional chemical systems.

# SUPERSONIC SUBSURFACE

▲ This power package is an integral part of a guided missile.

This gas-lift valve ▶ extracts oil from wells whose natural flowing days are over.



Both these products are examples of the management, engineering, research and production skills of U.S. Industries. Both are essential to American military and industrial strength.

The divisions that comprise USI produce *both* fire power and industrial power: from artillery shells, guided missile and aircraft components, to machine tools, storage tanks, electrical fittings, oil tools, steel pipe, giant metal forming presses. USI's newest division, the Kett Technical Center, performs research and development for both the armed forces and for industry.

The interdependence of military and industrial power is nowhere better exemplified than at U.S. Industries, a production team geared to American strength and progress.

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# COMMUNICATIONS

## THE RUSSIAN THREAT

THE EDITOR.—In spite of the technological advancements we are making and the great amount of money we are spending, I am not at all encouraged by results.

From where I sit it looks as if our position in the international field has been deteriorating slowly but surely for the past decade or more. Not that it makes any difference to me as an individual, for I have already used up most of my allotted "three score and ten," but it may be slavery for the next generation, from which they probably never will escape.

It is not what the Russians are doing that worries me, but what we are *not* doing. For example, on the very day that the Russians announced their ICBM we announced a new luxury automobile—to help kill off even more than 40,000 Americans a year.

While the Russians were launching their space-ball, we were wildly excited about the World Series. While the Russians are building submarines we are sitting around watching the fluctuations of the stock market.

If a lot of these people do not begin to think a little, and then *do something about it*, a lot of the people who are now swinging baseball bats and golf clubs will be swinging picks in Siberia.

DR. F. P. ARCHER, SR.
Miami, Fla.

## SCIENTIFIC EDUCATION

THE EDITOR.—I have been a member of the American Ordnance Association for a great many years and continue to be very much interested in its work.

I am in receipt of your Bulletin No. 206 of December 1957 regarding scientific education for armament preparedness. In view of developments that have been featured in the press, particularly in the last two months, a great deal has been said on the importance of training scientists, engineers, and technologists. Those of us who have been in such work over many years have long since recognized the vital importance of training an adequate number of qualified technical people.

However, I am convinced that the problem is a lot deeper than might appear from the statements that have been broadcast. It is my firm opinion as a scientific man that those who have the innate talents to become first-class scientists and technologists become the men who will do such outstanding work in these fields subject, of course, to sound basic education and proper training and experience.

I believe that the basic education necessary, particularly in the secondary schools, must be substantially improved and that such improvement will come primarily from the reintroduction into our educational systems of methods that will be really disciplinary. It is, of course, vital that men trained for science and technology have this type of educational foundation in order to develop the greater skills brought out through further training along scientific lines.

At the same time, the portion of the public that is educated, or capable of education, should have comparable disciplines in the primary and secondary schools so that they may have at least a reasonably intelligent understanding of the significance of scientific thinking and work so that they themselves will call for a much-needed improvement in our school systems and methods of education of our youth.

As a part of this earlier disciplined education, the average student will likely develop a greater and more intelligent interest in scientific matters, and the promising youths who have talents to become scientific men will be readily recognized and can be encouraged and aided in getting more advanced scientific education.

In other words and in simple language, it isn't possible to pull human material with adequate scientific talents out of a hat.

My purpose in sending this communication is to ask consideration of the broader requirements and impact on our country's future welfare. Severe disciplinary methods in education in Russia prevailed long before the present regime. The quality of many scientific minds in Western European countries as well as in Russia was established during the period of secondary training in their youth.

P. E. LANDOLT
New York, N. Y.

## OF BOWS AND ARROWS

THE EDITOR.—A few lines (fact versus fiction) in regards to Lieut. Comdr. G. V. Hurley's article, "First Precision Missile," appearing in the November-Decem-

# Sperry's combination radar test sets integrate all testing functions

Faster, simpler radar maintenance is the pay-off with the Sperry Combination Test Sets. One set does the job of three or more standard test units but requires one-quarter the space and weighs half as much! Here are the five functions each Sperry test set performs:

**POWER METER:** Directly measures average power of radar transmitter with accuracy of ± 1.0 db.

**FREQUENCY METER:** Indicates directly the frequency of both receiver and transmitter.

**SPECTRUM ANALYZER:** Accurately displays power vs. frequency spectrum of transmitter signals from single or multi-pulse systems. Display is stable at all pulse widths and repetition rates.

**SYNCHROSCOPE:** Simple general-purpose synchroscope functions as an "A" scope and displays radar video signals or similar wave forms—no need for auxiliary synchroscope.

**SIGNAL GENERATOR:** Accurately and directly calibrated output signal level is variable over complete range. Choice of pulse, frequency or external modulation.

With no additional equipment you can also measure transmitter peak power, repetition rate, transmitter pulse width, T.R. recovery time, duplexer losses, transmission line VSWR. Designed for tough operating conditions, these sets comply fully with military specification MIL-T-945A. Your nearest Sperry district office will gladly supply you with complete operating data.

Microline Model 570
16¾" L x 15⅝" W x 15⅞" H

COMPLETE LINE OF TEST SETS

| Band | Microline* Model | Military Type | Frequency |
|---|---|---|---|
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| S | 590B | UPM-44B | 2700-3500mc |
| C | 551A | SPM-5 | 5100-5900mc |
| X | 570 | UPM-32 | 8500-10500mc |
| K | 557 | | 23500-24500mc |
| V | 580A | UPM-14 | 34000-35600mc |

*T. M. Reg. U. S. Pat. Off.

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LINDSAY PRESSURE GAUGE used in jet aircraft. Model #6907-1 shown here in actual size; total weight .20 pounds. (Other models for missiles and special applications.)

**NEW LINDSAY GAUGE**

*designed for jet pressure systems*

The RMC-Lindsay Pressure Gauge for jet aircraft is made for extensive cycling—will meet rigid endurance and over-pressure requirements. Not even the most extreme conditions of shock, vibration or temperature disturb its accuracy. Pressure ranges from 1,000 to 15,000 psi.

The RMC-Lindsay Gauge is a bourdon tube type, using a multiple coil, helical bourdon tube with the pointer attached directly to the end of the coil. The life of the Lindsay helical bourdon coil, as compared to the traditional "C" spring bourdon gauge, is more than 10 times greater and its proof pressure limits are increased by a factor of 3 or 4. The helical bourdon tube also eliminates the use of linkages and pivots, improving the gauge's shock resistance by a factor of 5 or 10.

The helical bourdon element is, of course, not a new development. However, the RMC-Lindsay techniques in coiling, heat treatment, calibration and material specifications *are* new—and exclusive with RMC.

Whatever your high pressure gauge problems may be, why not let RMC engineering skill provide the answers. Write to either of the below addresses, outlining your particular requirements.

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**92 Beacon Place—Pasadena, California**

**ROCHESTER MANUFACTURING COMPANY, INC.**
**220 Rockwood Street—Rochester 10, N.Y.**

RMC
LINDSAY PRESSURE GAUGES

## Communications (Contd.)

ber 1957 issue of ORDNANCE. If, in part, the performance data credited to ancient bowmen and their arrows are to be regarded as mere mythology, it is an excellent article. If however, some of the truly remarkable impact values are to be associated with fact—then it may be said with certainty that a reëvaluation (obtained from actual scientific tests) would remove much of the "Hollywood" and reveal an entirely different story.

Picture an arrow fired from a 75-pound bow as traveling slightly better than 100 miles an hour as stipulated. This is a velocity of approximately 160 feet a second. This speed imparted to the usual 1¼-ounce broadhead arrow would develop about 31.5 foot-pounds of energy as it leaves the bow—a rather mediocre impact value in comparison with even a caliber .22 rimfire bullet which is capable of muzzle energies in the 150- to 200-foot-pound bracket.

Here are some actual results with modern hunting arrows fired from bows of 70-pound pull and upward:

*Metal test.*—Fired at close range into a sheet of aluminum 3/16-inch thick. The arrow rebounded, the impact leaving a ½-inch-wide slot cut into the sheet. The arrow naturally failed to pass through the metal.

*Wood planking test.*—Maximum penetration achieved in seasoned soft wood was approximately one inch.

*Plywood test.*—Penetrations were achieved through 3/8-inch material, with very little remaining energy.

*Glass test.*—Maximum penetration was established as being ¼-inch. Arrows fired into or at hollow glass building blocks usually broke or shattered and likewise partly shattered the impact face of the glass blocks.

*Sand test.*—Fired into a light sheet-metal waste basket filled with dry sand. The arrows remained in the basket with the heads usually emerging from the far side.

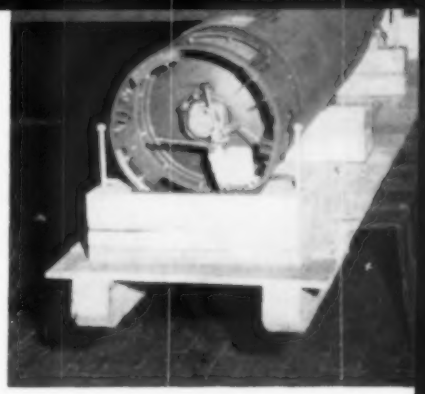
My own observation with steelhead arrows fired into dry hemlock boards from 70-pound bows closely parallels the finding of approximately one-inch penetration as reported in the tests described above.

Long effective ranges and remarkable penetrations are spoken of by Mr. Hurley in his article, such as: 4 inches of brass, 7 thicknesses of boiled hide armor, 8 inches of wood after passing through a suit of armor, ¼-inch steel plates, the killing of horses at 250 yards, etc.

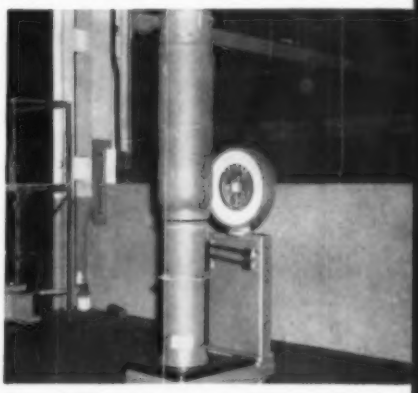
It would be quite an accomplishment to hole four inches of A-1 quality rolled solid brass plate even with a standard 20-mm. aircraft cannon—let alone a reed arrow from an ancient bow, or any other bow!

H. F. KOHLBACKER

Buffalo, N. Y.



Forward end view of engine showing igniter assembly in place.



Completely balanced engine assembly is given final check for compliance to weight.

# Zoom... PARISH puts the power behind this missile!

**Parish-built rocket engine fires U.S. Army's Lacrosse missile.**

The U. S. Army's Lacrosse missile takes to the air. This surface-to-surface guided missile is a rugged, close and general support all-weather weapon of high accuracy with a single shot kill power. *Parish* is producing the engine. Martin-Orlando makes the missile.

The engine and its numerous components require the utmost in precision engineering, fabrication and assembly. Balancing and weight are critical. For instance, the weight of the entire unit must be within $\pm\frac{1}{4}$ of 1% of the total. Production fixtures and jigs had to be engineered for duplicate accuracy because any engine must fit any missile.

Parish Pressed Steel is the first company to successfully mass produce these solid-propellant engines. The reason: *Parish* has the unique combination of engineering experience, production know-how and precision equipment needed for such critical ordnance work. They're available for additional work right now. Call or write for additional information . . . today.

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# RECENT PATENTS

*This department on recent military-industrial patents is being published in* ORDNANCE *to keep our readers informed of the latest developments in these fields. The data are compiled by Melvin Nord, patent attorney, Detroit, Mich. Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each.*

**Cable Cutter.**—*U. S. Patent No. 2,806,442. Issued September 17, 1957, to Robert Temple. Assigned to Temple Velocity Equipment, Inc.:* This invention provides a device for cutting the lines by which explosive mines are anchored below the surface of oceans, in which the cutting member is actuated by an explosive charge. It can cut both hard and soft chains and cables, is relatively small and lightweight, cannot be fouled by an anchor line, and is substantially free of the possibility of failing to operate.

**Lightweight Rocket Launcher.**—*U. S. Patent No. 2,800,835. Issued July 30, 1957, to James W. Mayer. Assigned to the Secretary of the Army:* This patent provides an automatic or semiautomatic rocket launcher which is simple to operate and light in weight. The speed of firing is limited only by the rate at which rockets can be fed into the magazine. Feeding may be by hand in field installations or automatically. The doors must be fully closed and locked before a loaded rocket can be launched. The firing of a rocket automatically indexes a succeeding rocket into the launcher tube.

**Barbed Wire.**—*U. S. Patents Nos. 2,801,080 and 2,801,081. Issued July 30, 1957, to Jacques L. A. See:* These two patents provide movable and folding barrier components forming barbed-wire entanglements which can be transported flat and which are useful for military purposes.

**Detonation Trap.**—*U. S. Patent No. 2,801,517. Issued August 6, 1957, to Maurice J. Zucrow and Thorp B. Walker. Assigned to Aerojet-General Corporation:* This patent provides a safety device for preventing the propagation of explosions through conduits conveying explosive liquids, as in a jet-propulsion motor. The detonation or explosion is usually of minor consequence when at the motor or in the conduit, but if it is carried back to the liquid reservoir, a major explosion could result.

An explosion trap is therefore provided in order to reduce this hazard. The trap contains a frangible section of conduit followed by a conduit section which is looped so as to be brought back to a position close to the frangible section. When a detonation wave travels back through the conduit toward the reservoir, it divides at the trap. The detonation will first shatter the frangible section, and then, as the detonation wave traveling around the loop reaches the frangible section, it is interrupted at the broken frangible section, and will not be carried back to the reservoir.

**Liquid-Propellant Gun.**—*U. S. Patent No. 2,804,804. Issued September 3, 1957, to James M. Cumming:* This invention relates to an apparatus for impelling a

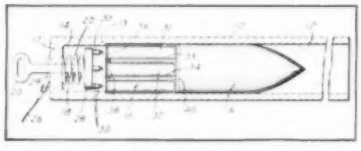
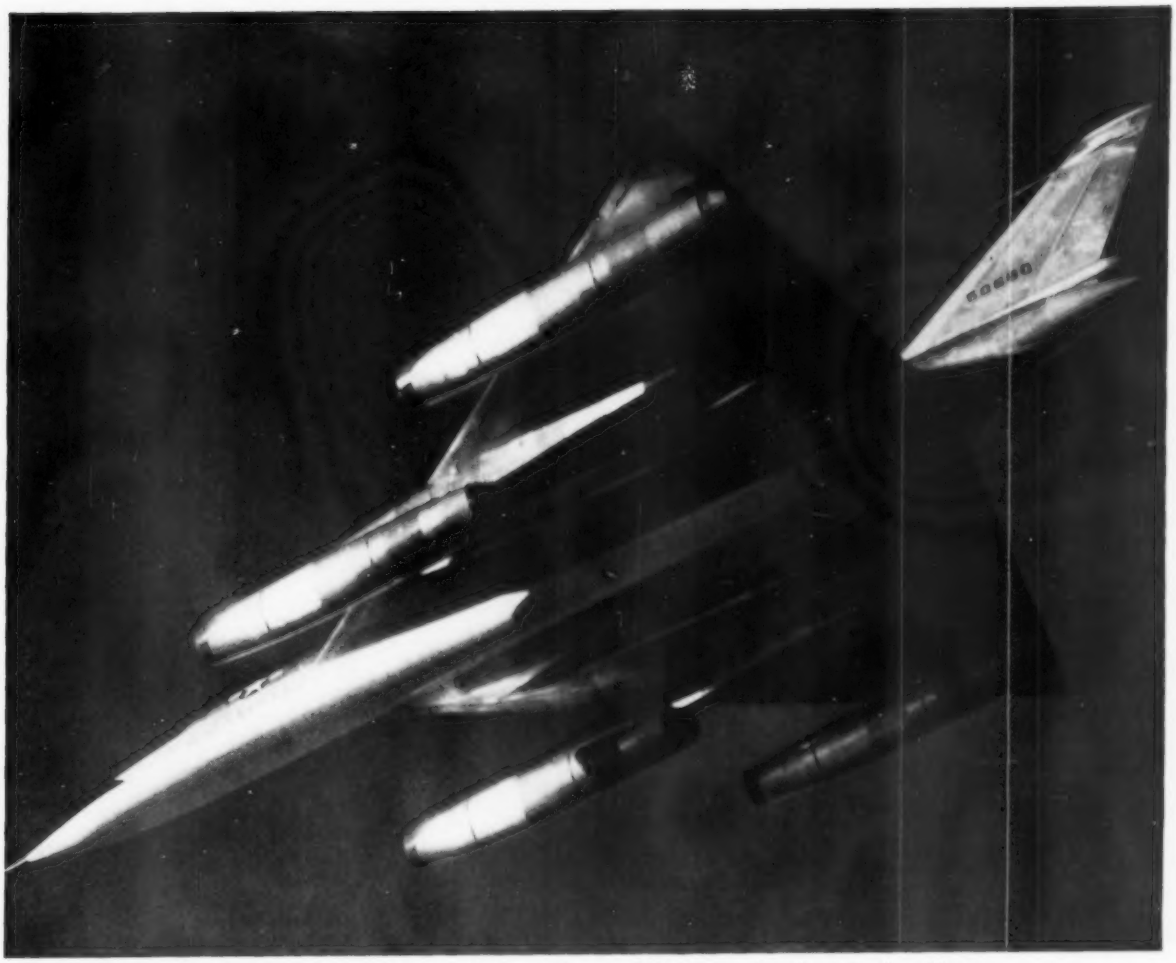


**Fig. 1. Gun and propellant assembly.**

projectile from a gun. As shown in Figure 1, a muzzle-loading gun contains a propellant assembly 15 and a projectile 16. The propellant member consists of two hypergolic liquids 31, 32 contained in concentric canisters 33, 34 having frangible rear diaphragms. When pin 24 is withdrawn, spring 22 moves the plunger 18 forward, causing pins 30 to rupture the diaphragms. The liquid contained in the canisters will ignite by contact and burn, producing high-pressure gases.

**Stabilizer for Missiles.**—*U. S. Patent No. 2,801,571. Issued August 6, 1957, to Robert Lusser:* This patent describes a device for stabilizing a missile while it is being launched by rocket power from a submarine or other floating platform by booster rockets. The invention increases the safety of the launching operation by applying a retarding force to the rear end



**Streaking through the air** faster than speed of sound, the B-58 Hustler depends upon nickel-containing stainless steel to withstand the tremendous heat developed by engine exhausts. B-58 is built by Convair, a division of General Dynamics Corporation.

# How a nickel-containing stainless steel keeps Hustler from being "skinned alive"

At the speed the Hustler flies, heat from air friction is a problem.

Where this heat is amplified by heat from the powerful jet engines, the plane's skin could overheat dangerously . . . lose strength.

Convair engineers overcome this by cladding portions of the Hustler exposed to the exhaust blast with "honeycomb sandwich" panels made of a special nickel-containing stainless steel. Thin ribbons of stainless steel are formed into a honeycomb shape which is then sandwiched between two thin sheets of stainless steel.

They use 17-7PH stainless steel, produced by Armco Steel Corporation, because it has five times the yield strength of low carbon steel, and it retains much of its strength even at 900°F.

17-7PH stainless steel honeycombs provide the high strength, stiffness, and low weight needed by the Hustler as it outspeeds sound, 50,000 feet above the earth.

**Does some metal problem face your staff?**

Is it a problem that involves heat, cold, corrosion, wear, stresses, fatigue? Or is there some other obstacle? There's better than a fair chance we can help your engineers get off the ground. Or at least work with them to trim the problem down to manageable size. Suggest that they send for a copy of "Stainless Steel in Product Design" and an Inco analysis sheet that will help them define the problem.

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*Designers* Gearmotors and Special Electrical Equipment *Manufacturers*

## Recent Patents (Contd.)

of the missile fuselage during launching thus producing a stablizing moment around the center of gravity of the missile, counteracting undesired deviations of the missile in pitch and yaw. The stabilizing force is applied by a flexible cable or wire which is payed out from a drum mounted on the ship.

**Rocket Igniter.**—*U. S. Patent No. 2,801,585. Issued August 6, 1957, to Rex L. Smith. Assigned to the Secretary of the Navy:* This patent provides a hermetically sealed squib for use in igniting the propellant grain of a solid-propellant rocket motor. The squib has substantially no brisance and a relatively long shelf life. It may be immersed in water numerous times without adversely affecting its operation.

**Fire-control Apparatus.**—*U. S. Patent No. 2,803,061. Issued August 20, 1957, to Richard E. Jortberg:* This patent provides a fire-control apparatus that will enable a ship to obtain range and bearing of a target from range and bearing of a reference point, where it is impossible to sight directly upon a shore target from a ship. Modifying data relating the reference point to the target is introduced in the apparatus whereby a continuous indication of bearing and range from ship to target is automatically obtained.

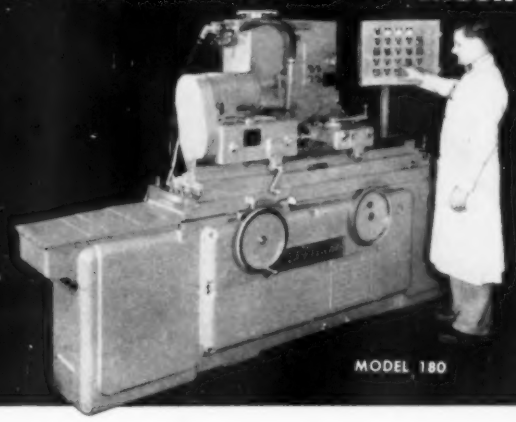
Data on the relation of the ship to the reference point is applied to the apparatus continuously, and data on the relation of the ship to the target is obtained continuously. The transformation from one relation to the other is direct, continuous, and accurate.

**Toss Bombing Device.**—*U. S. Patent No. 2,805,601. Issued September 10, 1957, to Harold S. Morton. Assigned to the Secretary of Defense:* This patent relates to a method of plane-to-plane bombing. The object is to destroy individual aircraft in bomber formations or force their dispersion so that pursuit planes can deal with the bombers individually.

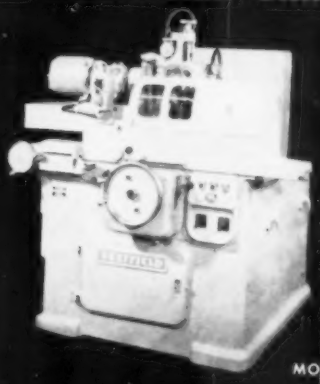
The pilot of the attacking aircraft flies, at uniform velocity, on a straight-line course which, if continued indefinitely, would cause him to collide with the target. While still a safe distance away from the target he determines his distance from it and accelerates upwardly for a long enough time to ensure that the velocity of the bomb, when the latter is released shortly thereafter, will be such as to cause it to cross the original line of flight of the bombing plane close enough to the theoretical collison point so that the fuze will function.

The patent contains a thorough mathematical analysis of this "head-on attack method" and a description of the apparatus used to operate the bomb-release mechanism at the appropriate time.

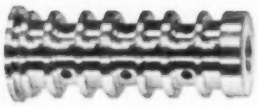
# Grind PRECISION FORMS, GROOVES and LANDS in Record Time with SHEFFIELD'S CRUSHTRUE MULTIFORM GRINDERS



MODEL 180



MODEL 109



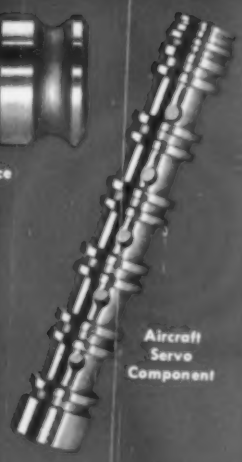
Servo Mechanism Sleeve

The seven grooves of this servo mechanism sleeve are crushtrue ground from the solid to a tolerance of .001" on spacing and .002" on minor diameter in 55 seconds. Material, SAE 52-100; Rockwell, 58-60 C; depth of plunge grind, .145".

Forms and grooves are precision ground on these machines with comparable speed and economy.

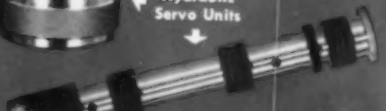
**For complete details write to Department 14, The Sheffield Corporation, Dayton 1, Ohio, U.S.A.**

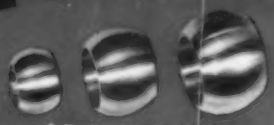
Bearing Race



Aircraft Servo Component

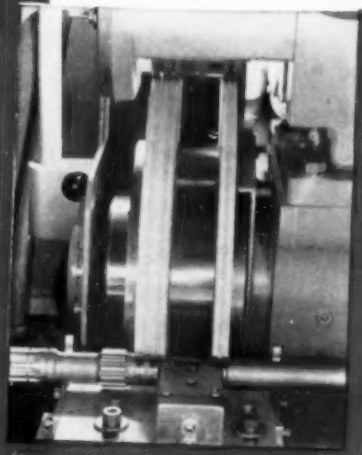
Hydraulic Servo Units





Self-aligning Bearings

Crushtrue Roll



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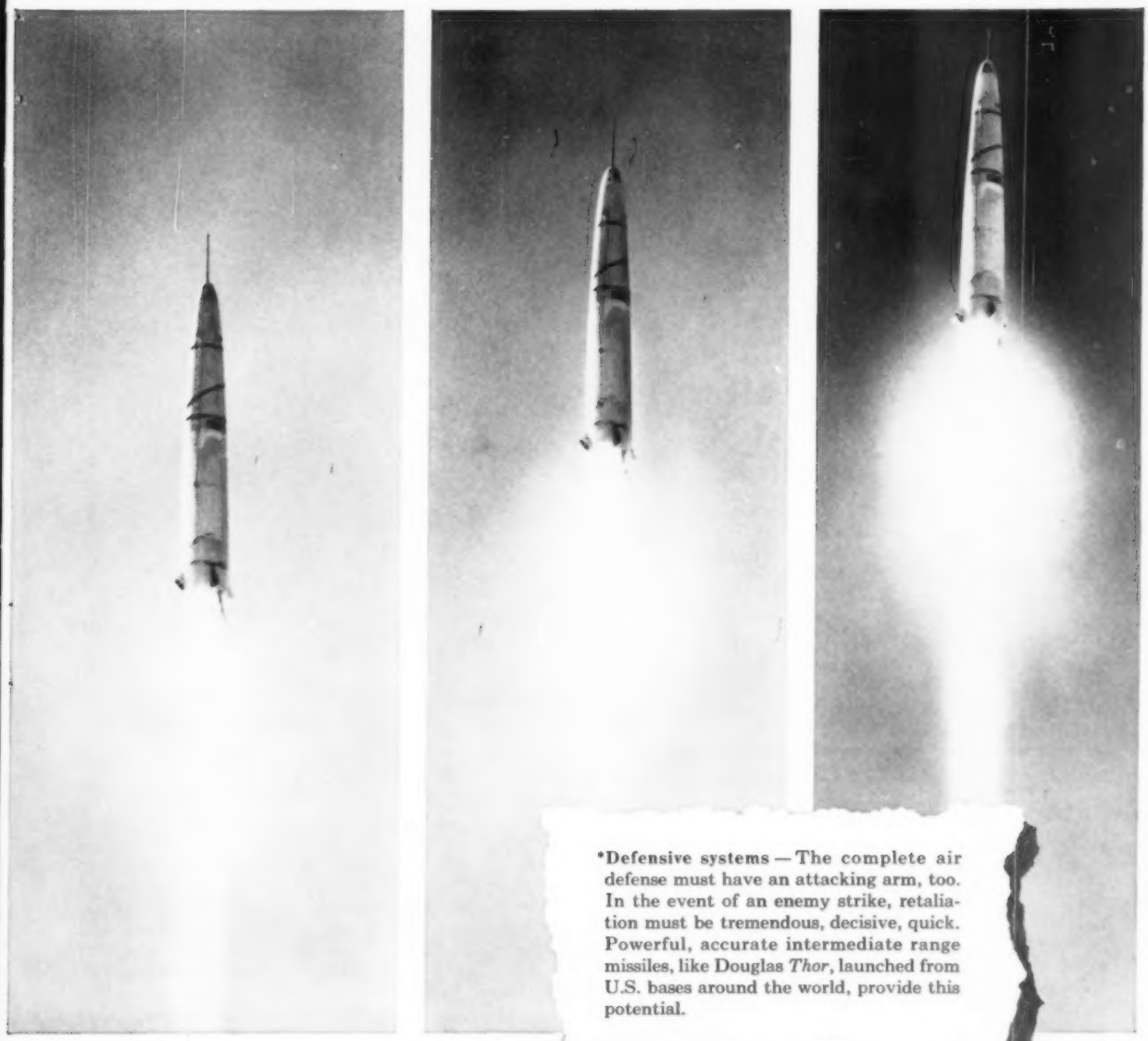
At the same time the science-industry-military team which cooperated in developing *Thor* readied the important systems required to make it operational... transportation, fuel-



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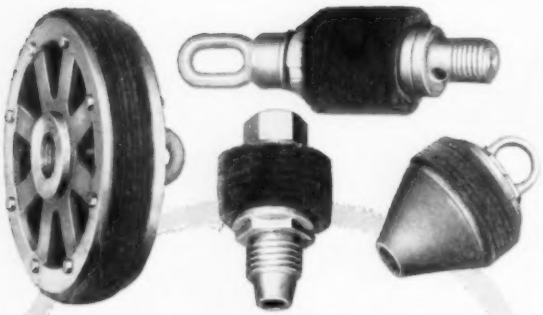

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# Book REVIEWS

**Reviews in this issue by:**

COL. GEORGE S. BRADY, *consulting engineer, author, editor, Washington, D. C.*

COL. LEO A. CODD, *editor, Washington, D. C.*

F. W. FOSTER GLEASON, *military historian, ordnance analyst, editor, Washington, D. C.*

R. E. LEWIS, *editor, Washington, D. C.*

MAJ. GEN. E. P. MECHLING, *ordnance engineer, aircraft armament expert, Washington, D. C.*

G. W. SCHIFF, *electronics engineer, Bedford, Mass.*

R. K. SMITH, *editor, Washington, D. C.*

---

**The Great Deterrent.** By Sir John Slessor, Marshal of the R.A.F. New York: Frederick A. Praeger, Inc. 321 pp. $6.

IN this book, Sir John Slessor has given a clear insight to the thinking of an outstanding British airman. The series of articles written over a period of some ten years, with the connecting theme of nuclear retaliation by strategic bomber forces, helps us to understand British attitudes and actions during this period.

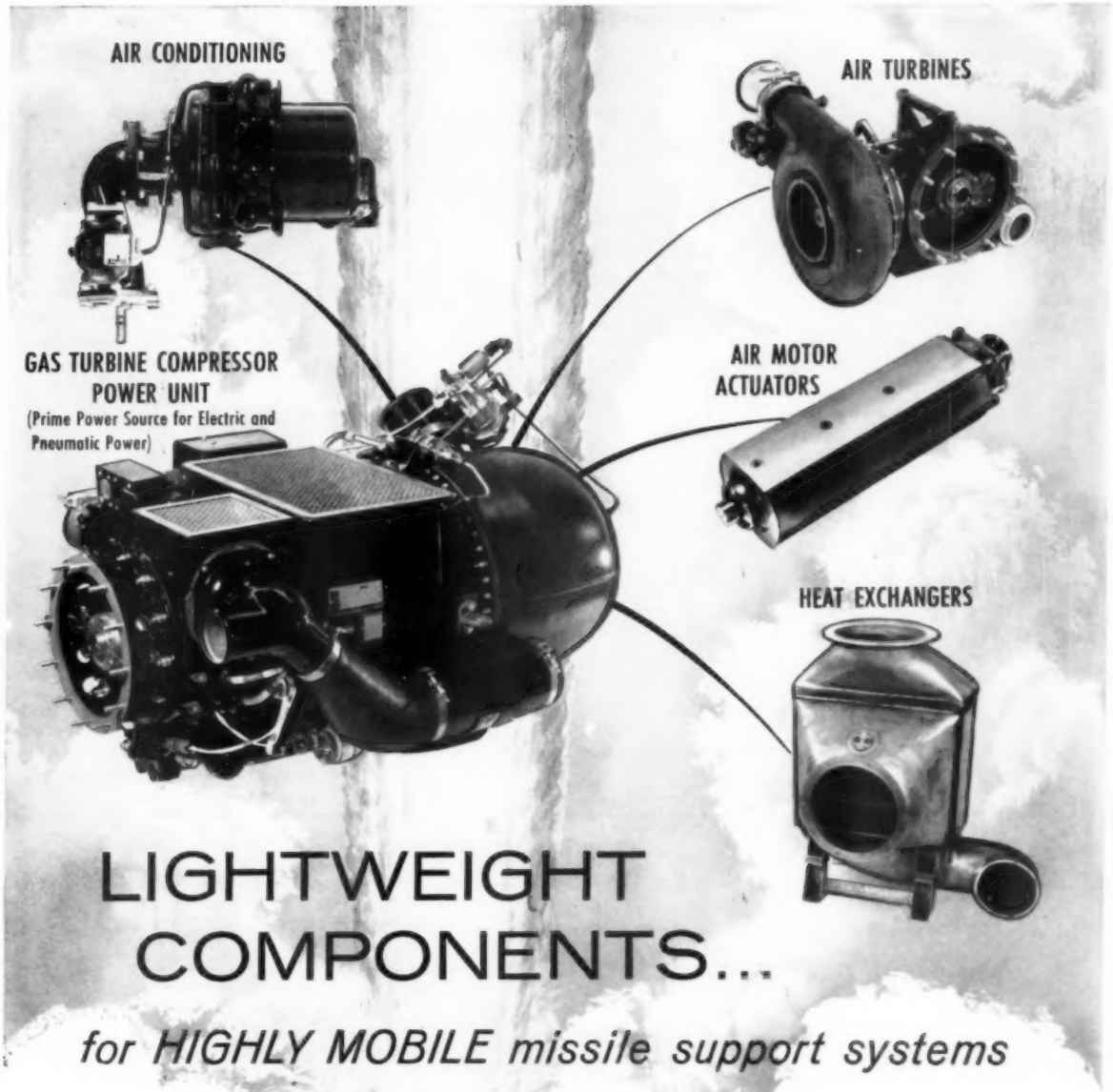
Sir John's views on the use of airpower, both strategic and air defense, are close to those held by military leaders in this country. His discussion of disarmament and the international stability it requires represents the European view of compromises and balances of power.

He attributes much of the postwar instability to our insistence on unconditional surrender, but he seems to lack our confidence that the best way of forcing Russia to make the necessary concessions to create a peaceful world requires the West to remain truly strong over a long period of time. He acknowledges Britain's reduced resources in sustaining this strength and seems to favor a demilitarized neutral zone across Europe and possibly in the Middle East and Far East as a basis for Russian concessions and international stability.

It is clear from this book that if the United States and Britain had maintained agreement on international objectives and actions, many of these past mistakes could have been avoided. This kind of an agreement is a 2-way street—if we can use it the world's future will be better.—EDWARD P. MECHLING.

**The Bridge at Remagen.** By Ken Hechler. New York: Ballantine Books, Inc. 238 pp. $0.50 (paperbound) $4.50 (clothbound).

THIS book makes a valuable addition to military strategy. The author already has a good reputation as a professor of political science, and with his way of getting at facts by personal interviews and his ability to analyze characters and situations he is likely to obtain a permanent place as one of America's great historians. (*Continued on p. 886*)

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## Book Reviews (Contd.)

Remagen, militarily speaking, was more than a bridge, as it involved ten days of bitter fighting to secure a foothold in difficult terrain not anticipated in the general plan, and also questions of command that have always been problems in military schools.

Since the days of the Wellington campaigns, military staff colleges have discussed almost fruitlessly the question of how far junior officers can depart from general orders so as to take advantage of unforeseen conditions which they find in their path. It was Warren's on-the-spot judgment in ordering a passing regiment to seize Round Top that gave the Federals an unlooked-for advantage at Gettysburg.

At Remagen Bridge it was a second lieutenant who discovered the possibilities, and Colonel Engeman knew that he was violating orders when he radioed to Brig. Gen. W. H. Hoge: "Bridge intact. Am pushing doughs to other side." Reached by telephone at First Army, General Hodges instantly grasped the situation, and, in spite of SHAEF's well-known reputation for being "morbidly sensitive to criticism" he seems to have had no difficulty in getting instantaneous approval for the change in plan from Generals Bradley and Eisenhower.

The book is well documented from personal interviews with both American and German participants and is written in a most interesting fashion. It can be read as an epic adventure story, but it will be most useful as a study on tactics and strategy.—GEORGE S. BRADY.

**Soldiers of the States.** By William H. Riker. Washington: Public Affairs Press. 129 pp. $3.25.

PROFFESOR Riker presents a partial review of the rôle of the National Guard in the military record of the United States. Guardsmen will not be pleased with his analysis for the good and sufficient reason that the heroic achievements of the Guard in battle throughout our national record receive scant mention. After all, the shortcomings of any organization cannot be described in detail and with justice if the achievements do not receive commensurate emphasis.

The author is an associate professor of political science at Lawrence College. His research on this book was supported by grants from the Rockefeller Foundation and the Social Science Research Council. His specific object was to examine in detail the duality of the militia in both its historical and its contemporary form. Indeed, the distinct feature of the National Guard is its dual command and its dual loyalties.

The record of our National Guard in time of peace may have distinct political overtones. But this is in the nature of the organization itself. Its redeeming grace has always been that the Guard brings together neighbors and friends to fight side by side in a military group with the same basic community background.

This reviewer holds unwaveringly to the belief, fortified by the record, that morale, zeal, and loyalty—the priceless intangibles—are strengthened when the members of the group are of the same origins and interests. In this respect the advantages of the Guard are of the same proportion as the advantages of our individual States versus a centralized federal system.

Our National Guard is of the same texture as that of our sovereign States, and its shortcomings are no greater than those inherent in any large military organization. This reviewer will require a more convincing story than Professor Riker has written to affect his allegiance to the strength of our dual system as written into our Constitution.—LEO A. CODD.

**The Rebel Shore, The Story of Union Sea Power in the Civil War.** By James M. Merrill. Boston: Atlantic—Little, Brown & Company. 245 pp. $4.75.

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DEALER INQUIRIES INVITED


## Book Reviews (Contd.)

a navy that had atrophied with forty years of inactivity and meager appropriations was a herculean task facing the Union at the outset of the Civil War. The home squadron consisted of 3 ships, 21 smoothbore guns, and 207 enlisted men.

All craft that floated were commandeered for purchase—steamers, ferryboats, whalers, coal barges, tugs, and fishing boats. But the most formidable task was the building of a competent officer corps against the opposition of the bewhiskered relics who held their high jobs through the operation of the longevity system.

Now, a century later, when the bitterness has subsided and both sides can view the case as an American problem that we cannot afford to let happen again, the author tells the story in an interesting, amusing vein.

The Southern planters boasted that "God Almighty couldn't take the forts." The Negro slaves slyly answered, "But the Yankees are coming with God Almighty." The Negroes seem to have been right because there was no display of greatness or cleverness on the part of the Union leaders during the first three years of the war.

At the outset the ports were poorly defended, and General Lee warned that they could not be held unless a concentrated army threat in Virginia were made to divert the whole Union effort into that area. Roanoke Island was taken in January of 1862, and the fleet could easily have taken Wilmington, Charleston, Savannah, and Jacksonville, but these ports, later strengthened by the Confederacy, remained open to the flood of war matériel brought in by fast blockade runners from the neutral rendezvous at Havana, Nassau, and Bermuda.

Adm. Samuel Du Pont, the "dignified, wealthy member of the comic opera Old Navy," suffered from "a disease called apathy." Commodore Stringham was named in Washington as "Can't do this, can't do that, Holy Joe." "Little Napoleon" McClellan, tense with his own importance, moved his army only to the parade ground, readying it for his prospective grand march to Richmond, and refused to help the Navy with landing and occupation troops. Maj. Gen. Ben Butler, designated as the "loudmouthed political comedian," didn't like the looks of the forts and withdrew his troops. "Slow-witted" Gen. Tim Sherman kept his troops loafing on the sands at Port Royal.

The struggle of internal organization was a greater battle than that of fighting the Rebels. It was a long time before the Farragut-type fighter emerged from the line. The reader of this book will be amused, but at the same time he can absorb a worth-while lesson.—GEORGE S. BRADY.

**Van Nostrand's Scientific Encyclopedia.** Third Edition. Princeton: D. Van Nostrand Company. 1,839 pp. Until March 17, 1958, $26.85; thereafter, $30.

PREPARED by outstanding authorities, this third edition of Van Nostrand's excellent one-volume scientific and engineering encyclopedia is revised and greatly enlarged to reflect both the basic and the practical advances of the past ten years. It is complete and accurate enough for the professional, yet written in a simple, straightforward style easily understandable by the interested layman. An effective plan of using bold-face type within any one definition to indicate cross references makes thorough checking of a given subject fast and accurate.

Including over 100,000 definitions and 14,000 separate articles, this encyclopedia is a comprehensive reference library of the major sciences and fields of technology including: aëronautics, astronomy, botany, chemistry, engineering—civil, chemical, electrical, and mechanical—electronics, geology, guided missiles, mathematics, medicine, metallurgy, meterology, mineralogy, navigation, nuclear science and engineering, photography, physics, radio and television, statistics, and zoology. Over 1,400 illus-

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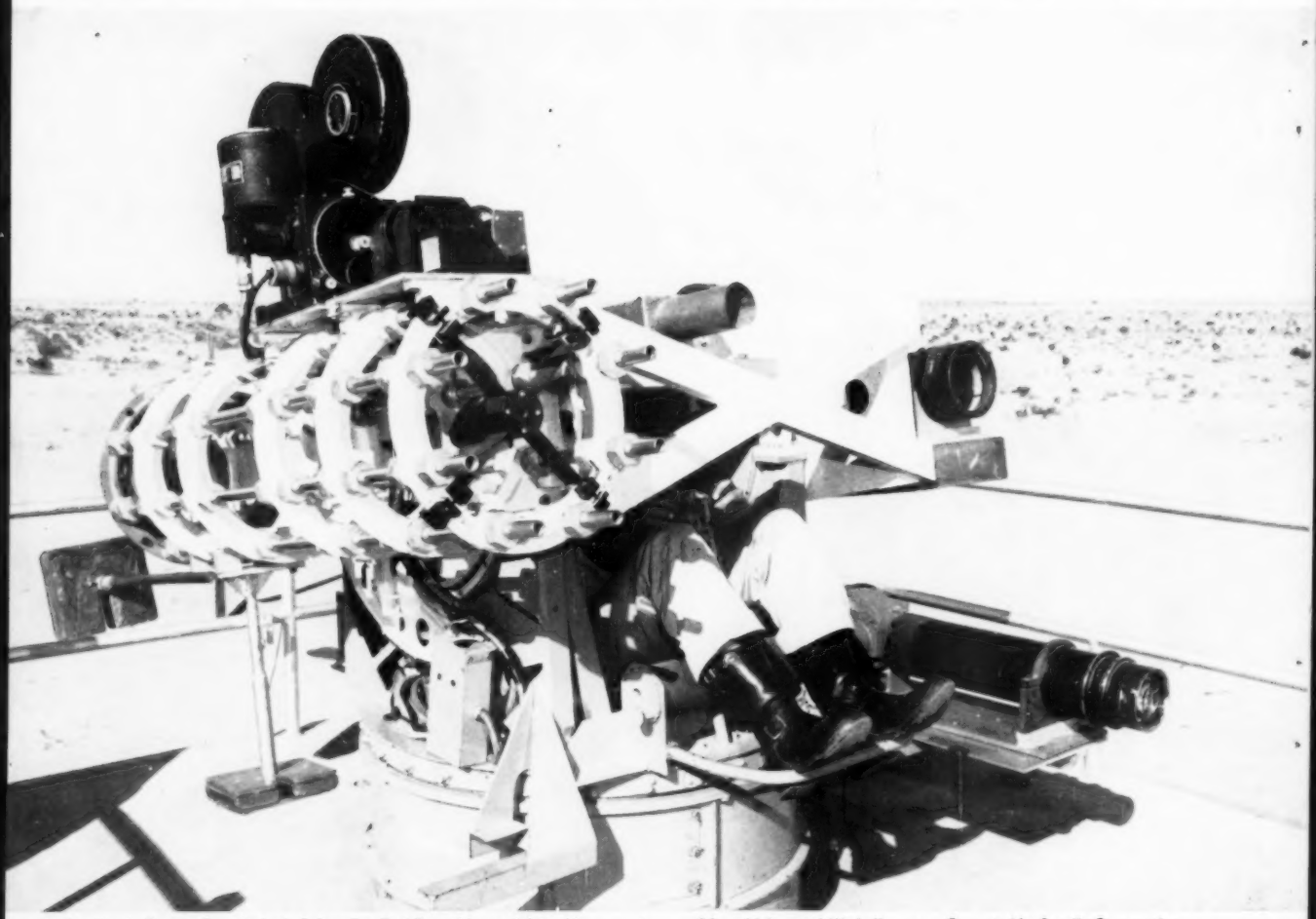
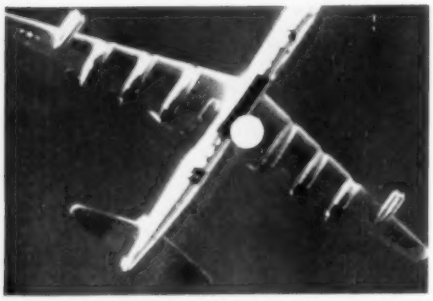


**At the Atomic Energy Commission's Salton Sea Test Base** this special tracking mount uses a 35mm high speed Mitchell camera. Operated by Sandia Corporation, this base uses Mitchell cameras for recording test operations.



**Tracking at 40,000 feet,** this film frame from a Mitchell camera operating at 96 frames per second provides an accurate record.

## Salton Sea Test Base Uses Mitchell Cameras to Capture High Speed Action of Dummy Bombs

High speed flight and laboratory tests, which hitherto have been difficult or impossible to view with the human eye, are today providing revealing information through high speed film recordings.

Typical example of the widespread use of high speed cameras is the Salton Sea Test Base in Southern California, where drop testing of "dummy" bombs is a major activity. In testing carried on there, by Sandia Corporation for the Atomic Energy Commission, as many as 20 Mitchell high speed cameras may record different angles in the flight of an experimental weapon "shape" from drop aircraft to impact area.

Operating at 48 to 100 frames per second, the Mitchell cameras film accurate, steady images with maximum uniformity—even under difficult and complicated filming conditions.

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## Book Reviews (Contd.)

trations, including 12 in full color, add to the clarity and interest of this valuable work.—R. K. SMITH.

**The Winter of the Bombs.** By Constantine Fitzgibbon. New York: W. W. Norton & Company. 271 pp. $3.95.

THIS is the terrible yet fascinating story of the Blitz of London from September 1940 to May 1941. During those dreadful months, 24,000 tons of explosives and hundreds of thousands of incendiaries were dropped on the city. Twenty thousand Londoners died, many thousands were injured, and vast areas were pulverized.

The author's account is drawn largely from interviews with the people who were there—a warden, firefighters, a charwoman veteran of the underground shelters, a patron of the Cafe de Paris who was dancing there when a bomb exploded in front of the bandstand. He talked to veterans of the RAF and the Luftwaffe and reviewed British and German documents.

Behind the tragedy and the horror there were humor, nobility, and kindness—an inspiring story of the heights to which human capabilities can rise and a timely lesson for all who sit in the shadow of the nuclear bomb.—R. E. LEWIS.

**Closed Circuit TV System Planning.** By Morris A. Mayer and R. D. Chipp. New York: John F. Rider, Publisher, Inc. 250 pp. $10.

THOUGH many applications of closed-circuit television are available for study, many more remain to be developed. The industrial television manufacturers cannot predict all the possible industrial applications and may never be able to do so until they have become thoroughly familiar with every process and problem of every industry. Since no one industry is likely to become so omniscient, the evolution of the medium will probably depend upon the ingenuity of people with imagination in all walks of life, be they engineers, educators, executives, evangelists, or any category in which the readers of this book might be included.

The section on "Application of Closed-circuit TV" was written for those in management having to decide on the usefulness of TV in their business. The section is well documented with pictures of industrial applications, and anyone with a little imagination can readily grasp the many possibilities that exist in nearly every industry for the use of TV.

The available equipment and the economics of its use are important considerations, and the remainder of the book is concerned with them. Because the closed TV field (and this includes operation over special radio frequencies as well as wire) is a rapidly growing one, the quality and quantity of equipment, as well as its application, are continually changing and the full value of this book will be short-lived.—G. W. SCHIFF.

### BOOKS RECEIVED

**Air Dates.** By Air Commodore L. G. S. Payne. New York: Frederick A. Praeger, Inc. 565 pp. $7.50.

**Gray Iron Castings Handbook, The.** Edited by Charles F. Walton. Cleveland: Gray Iron Founders' Society, Inc. 607 pp. NP.

**Heat.** By Alexander Efron. New York: John F. Rider, Publisher, Inc. 112 pp. $1.50.

**Heat Transfer.** Vol. II. By Max Jakob. New York: John Wiley & Sons, Inc. 652 pp. $15.

**Industrial Electronics Circuits.** By R. Kretzmann. New York: Philosophical Library. 192 pp. $10.

**Industrial Electronics Handbook.** By R. Kretzmann. New York: Philosophical Library. 298 pp. $12.

**Sound.** By Alexander Efron. New York: John F. Rider, Publisher, Inc. 80 pp. $1.25.

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GD

## THE SHAPE THAT MAKES MACH 5

By way of preamble, let us describe briefly the Arnold Engineering Development Center, a key Air Force installation at Tullahoma, Tennessee. This installation is being built by U. S. Army Corps of Engineers for the U. S. Air Force. (Design architects —Sverdrup & Parcel.) Its facilities will consist of wind tunnels for testing models and propulsion systems of aircraft and missiles under conditions simulating an incredibly wide range of altitude, airspeed and temperatures.

The propulsion facilities will comprise two large "closed circuit" type wind tunnels, of the same chamber size; plus compressors driven by a single set of motors developing 216,000 HP—a lot of muscle. The transonic circuit tests engines and airframes, or models, at air velocities reaching a modest Mach 1.5. The supersonic circuit can take such units to what was once the never-never land of Mach 5.

## THE NOZZLE'S THE NUB

Just upstream of the supersonic test chamber is a variable shape nozzle, the contour of which determines what air velocity is whipped up at the test section. The nozzle walls are two flexible steel plates, each 100′ long, 16′ high, and 1½-3″ thick. The walls, with 29 pairs of screw jacks on each, which are moved as desired, can mold the tunnel walls into any one of 300 different contours. Obviously, this is not the same as sinking a two-inch putt.

What's needed is the capacity to control these movements automatically or manually, keeping the tunnel operator visually apprized at all times of the wall positions.

So . . . where, you may ask, does Stromberg-Carlson come in?

We designed the electronic control system that positions the jacks and coordinates their motion with the required accuracy of ±0.008″ over a seven and one-half foot travel.

Here's the nuts-and-bolts story. The control system consists essentially of 29 "station units"—one each for the set of four jacks at each tunnel station. A memory and programmer feeds the positional commands to the various station units. An input section and control console permit the selection of the various modes of operation and actuation of the necessary safeguards.

## PULSEBEAT AND HEART

The memory is a magnetic tape on which are recorded, in block form, 29 trains of pulses, each about 40,000 pulse intervals long and corresponding to one of the 29 station units.

The heart of the station unit is a digital subtractor which compares the position of the steel plate (supplied by the position sensing system) with the commanded position obtained from the memory pulse train for that station. The difference, if any, is converted to an analog voltage which is fed to the jack motors in a direction that reduces the error.

All in all, the control system consists of 26 seven-foot racks with functional elements packaged as plug-in printed card modules; all circuits are transistorized.

## 200 PERCENTER

In the plant of a certain world-famous photographic firm, shutter assemblies for roll film cameras are automatically assembled and 200 per cent tested at the rate of 13,000 per day.

This feat of high-speed production and mathematically improbable testing is accomplished by com-

bining the camera maker's production machinery with Stromberg-Carlson test gear. Assembled shutters are automatically loaded on an endless conveyor in pallets which are positioned in successive assembly and test stations. After a shutter is tested at one station, it goes through a second identical station. Thus 200%.

Stromberg-Carlson made the two identical sets of high-speed electronic measuring equipment which are integrated with the assembly facilities. During each cycle the measuring circuits are successively activated, read out and reset by programming switches synchronized with the conveyor drive—at the rate of 30 test cycles per minute per station.

At the end of the test cycle the reject circuits are read out. Reject conditions are registered on tallying counters and stored in a memory drum synchronized with the conveyor drive. Rejected assemblies are automatically sorted in bins according to certain combinations of reject conditions. They can then be adjusted and retested.

The net result of all this: a significant reduction in the number of cameras returned from the field.

## OUTGROWTH

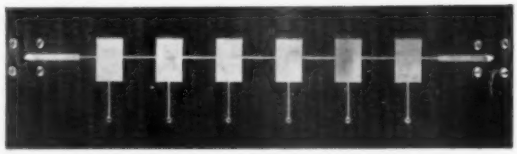
As one phase of a data link development program, ever-alert Stromberg-Carlson engineers have evolved a series of light, small, reliable rotary binary encoding switches.

They have 10 or 26 detented positions and use 6 brush pickoffs providing standard teletype code. One brush input is common and makes continuous contact with a metallic coded area on the insulated drum surface. The other pickoff brushes make or break contact with the common brush through the coded area, depending on switch position.

We've been particularly careful in the selection of "base materials" and in the fabrication techniques we use in making these switches. The brush connectors are pins which can be dip soldered into printed boards.

While the switches are basically equivalent to rotary tap switches having 5 decks, 5 poles, non-shorting 10 and 26 positions and hence should find many applications in all types of switching, their primary application is to digital encoding where small size and high performance are what you want.

## OUTGROWTH AGAIN



From a microwave development program we have evolved a series of microwave circuit elements which combine light weight, small size and (as the advertising fraternity says) *best of all, low cost*—with extremely low insertion loss and good termination. Through the good offices of precision printed wiring techniques, these units have been designed and operated successfully over a wide frequency range.

Illustrated here is one example, a band-pass filter. Others include antenna radiating elements, variable tuning sections and detector mounts. In certain applications these can be used singly; in others they can be combined so that they constitute, in effect, the entire r.f. section of a microwave receiver.

We've worked out designs which show very low insertion loss and exceptional impedance over wide ranges of frequency. Components have been designed for impedance levels ranging from 20 to 80 ohms.

While they have myriad applications in microwave receiving equipment, their primary destiny is to be used where low cost and small size must be combined with high performance.

You may find yourself thirsting for more data on all these matters, just for your own information. Or you may have a problem we can help solve. We offer our engineering talents and techniques. Write to Military Marketing Department at the address on the masthead.

*This is the first in a series of communications outlining unique developments, processes and techniques in electronics.*

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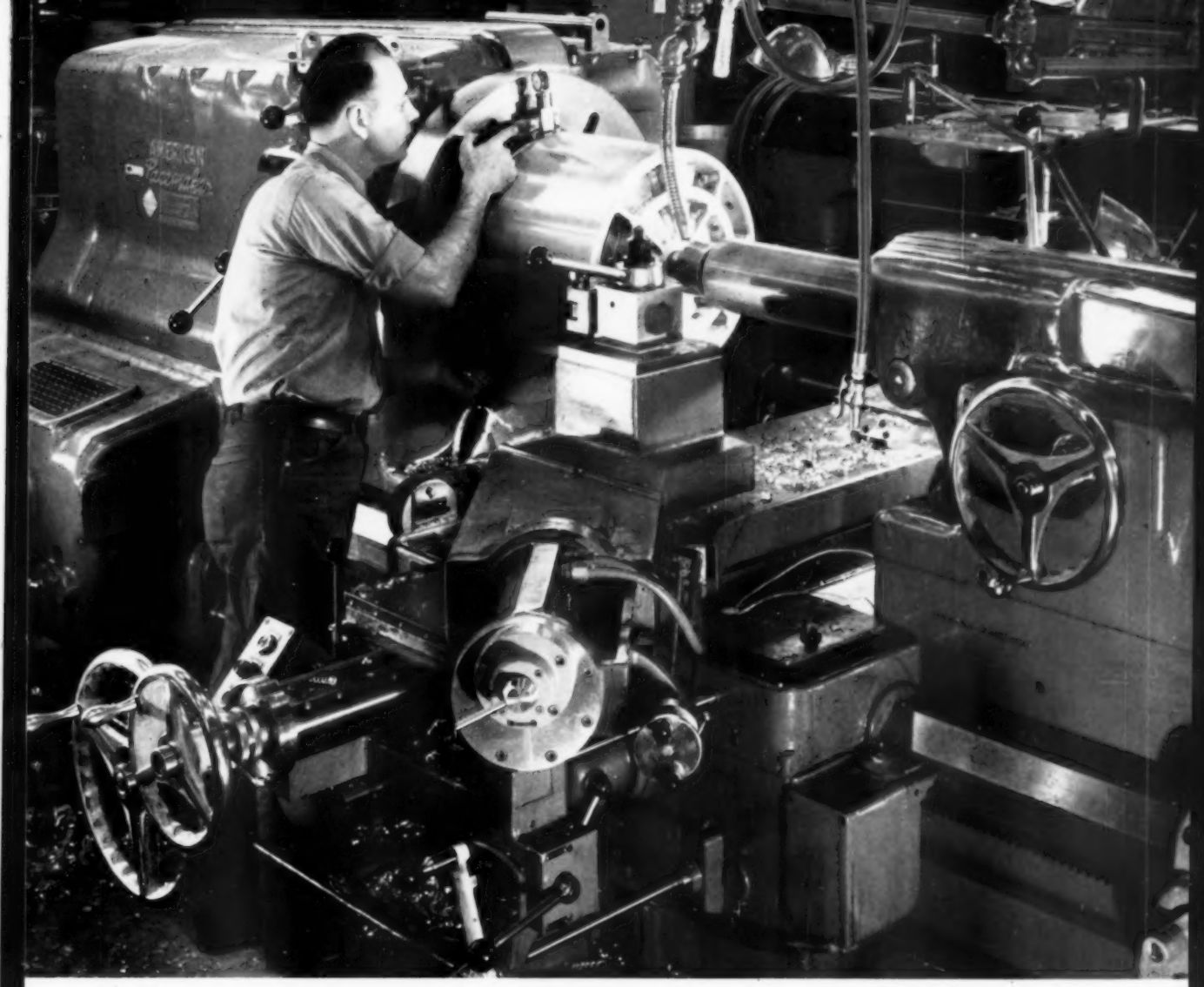

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General Mills

**MECHANICAL DIVISION**

*INTELLIGENT ENGINEERING AND PRECISION MANUFACTURING*

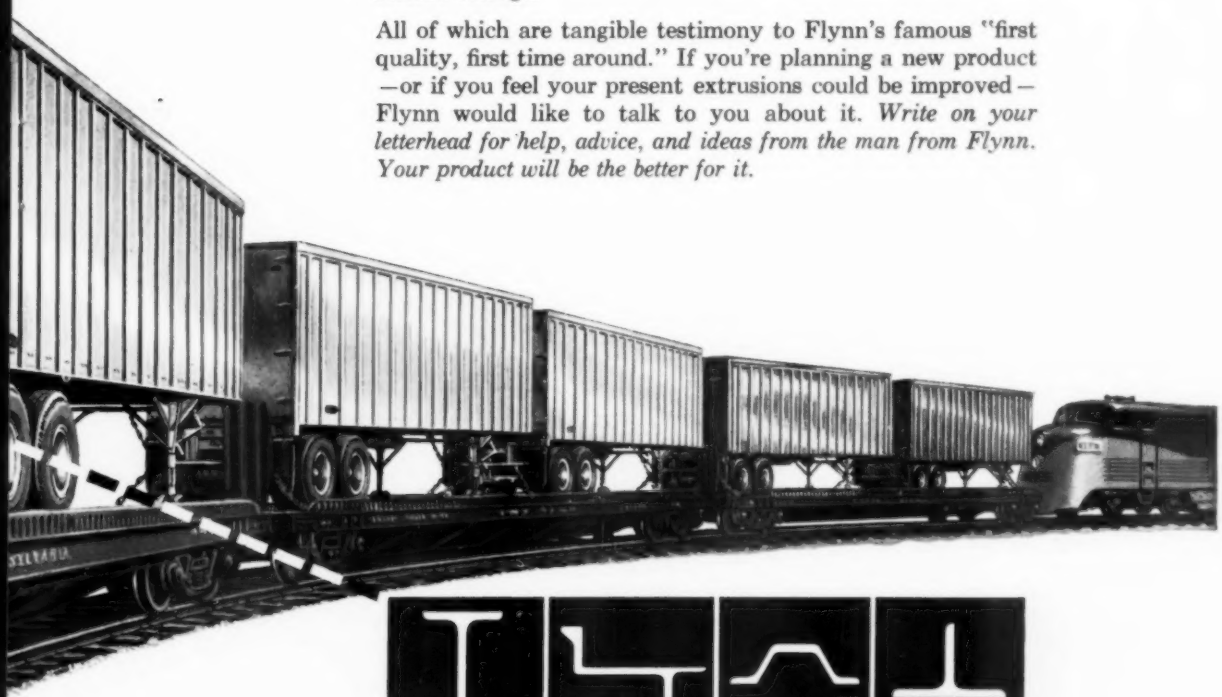
On the outskirts of a great Eastern city, in a bustling railroad freight yard, a "piggy-back" trailer train is being made up. Hours from now, at the station nearest their destination, waiting tractors will hitch up these trailers for the final few miles of their journey. This is the modern "piggy-back" ride, filling gaps in rail service and giving the railroads the mobility they needed.

# Flynn extrusions put the backbone in "piggy-back" trailer bodies

The vital "backbone" of these "piggy-back" trailer bodies—the sturdy aluminum sideposts, top rails, and bottom rails—are extruded shapes from Michael Flynn. Like the ribs in an umbrella, they give strength and rigidity to the trailer shell. These and similar Flynn extrusions are being produced for Strick Trailer and other leading manufacturers who, in turn, sell to the railroads and motor-freight firms.

"Piggy-back" trailer extrusions are a typical example of Flynn's imagination and experience in modern metallurgy. Other outstanding Flynn extrusion projects include bridge railing and posts for the new Chicago Calumet Skyway, hanger beams for Air Force jet rocket launchers, aluminum framework for geodesic domes, and automatic parachute release casings.

All of which are tangible testimony to Flynn's famous "first quality, first time around." If you're planning a new product—or if you feel your present extrusions could be improved—Flynn would like to talk to you about it. *Write on your letterhead for help, advice, and ideas from the man from Flynn. Your product will be the better for it.*



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### *Engineering Data*

Write for your copy of *Bulletin GC-106C*, a general catalog of all Arnold products. It contains useful data on Alnico Magnets, their physical and magnetic properties. Also lists stock items and standard tolerances for cast and sintered magnets.

**ADDRESS DEPT. O-83**

Your best bet when looking for a source of Alnico magnets and assemblies is Arnold—producer of the most complete line of magnetic materials in the industry.

Arnold can supply your need for any size or shape of Alnico magnet, as illustrated by the variety pictured above. Weights range from a few ounces to 75 pounds or more. Die-cast or sand-cast aluminum jackets, Celastic covers, etc., can be supplied as required. Complete assemblies are available with Permendur, steel or aluminum bases, inserts and keepers as specified—magnetized and stabilized according to the requirements of the application.

A wide range of the more popular shapes and sizes of cast and sintered magnets are carried in stock at Arnold. Unsurpassed plant facilities make possible quick delivery of all special orders. ● *Let us handle your magnetron, traveling wave tube and wave guide permanent magnet requirements, or any other magnetic material specification you may have.*

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A new radar was needed. It had to be light enough for easy transport, tough enough to withstand campaign conditions, and powerful enough to scan heights beyond the reach of any device previously available. The assignment of designing, building and producing it was given to Avco's Crosley Division. The MPS-16 height finder is the result. Working in cooperation with the ARDC's Rome (N.Y.) Air Development Center, Crosley has given the Air Force and Marine Corps another great contribution for national defense.

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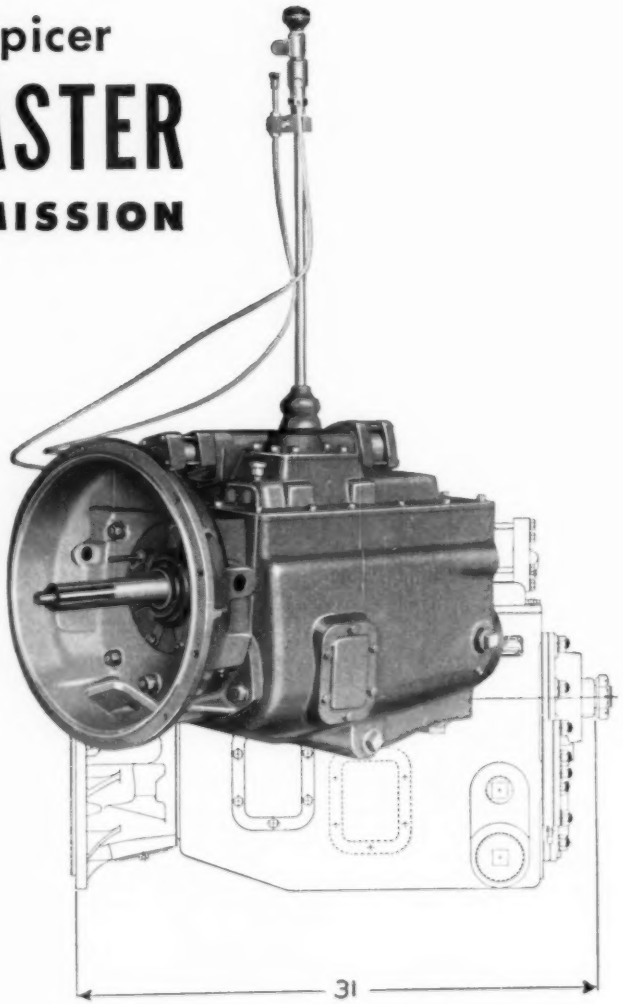
Now, for the first time, you can shorten the wheelbase by an even foot and increase payload by 200 lbs. . . . while eliminating the auxiliary transmission and two-speed axle. For the Synchro-Master 12 — with 12 evenly spaced forward ratios and 6 low-range steps in reverse — gives you top efficiency, both on and off the highway.

Available with either remote or tower controls, the new Synchro-Master 12 has blocker-type synchronizers for all speeds, forced feed lubrication, and standard 6-bolt SAE power take-off apertures on both sides. SAE No. 1 or No. 2 clutch housings are specified as required for either Spicer 14″ or 15½″ two-plate clutches.

Ask the Dana engineers to help you adapt this . . . shorter . . . lighter . . . more efficient . . . Spicer 12-speed transmission to your heavy-duty vehicle requirements. Or, write for a copy of the layout drawing of the Spicer Synchro-Master 12.

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**With Loewy's new automatic program speed control you can**

One of the largest presses in existence, this closed die forging press designed and built by Loewy, and in operation at the Wyman Gordon plant, North Grafton, Mass., features automatic program speed control.

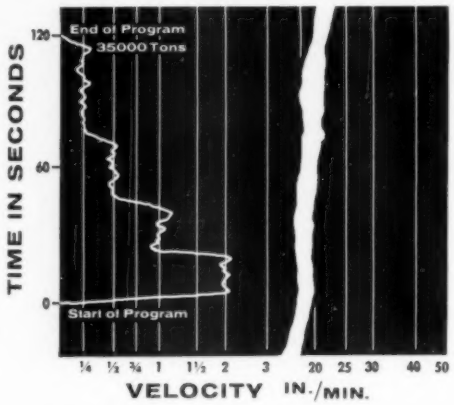
Structural and machine parts in aircraft, missiles and nuclear apparatus today demand greater strength and resistance to high temperatures, and many have extremely thin areas. Machining and other metal removing processes are not economical, due to the high cost of labor, waste of expensive alloy material, and loss of structural strength from cutting across the flow lines of metal. New metals, new methods and new equipment are needed for the economical production of parts that will consistently meet the severest requirements.

Regardless of which metal process is employed—extrusion, forging, die forging or deep drawing—the sound flow of material depends on so many variables that it becomes exceedingly difficult to coordinate them manually, especially in repeat performance. Excessively high speed may result in tears and uneven filling of die cavities. Unduly low speed may cause uneven cooling of material and, hence, interruption of the forming cycle.

To solve the problems of automatically controlling water-actuated hydraulic presses, Loewy-Hydropress had to bring to bear not only its resources in metallurgy and process engineering, but also its unique facilities in design of electronic controls.

The result is equipment which programs the change of speed and pressing force at preselected positions of the press stroke in existing installations. This makes it possible to translate experience in the production of high-quality metal parts into automatic repeat performance on any size hydraulic presses, including even the largest water-actuated presses, where such control was before unthinkable. Also it limits the maximum pressing force to a preset value and thus protects the tooling against overload.

For detailed information on the plastic forming of metals and on automatic controls for any machine process, write us today, Dept. H-3.




Graph shows a typical automatic control cycle consisting of four preselected speeds at preselected stroke positions up to 2 in./min. The workpiece is a 36-in. diameter steel billet. Pressure ranges from 6000 to 35,000 tons. Speeds range from ¼ in./min. to 2 in./min. and total pressing time is 2 minutes.

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Kendall Preston Jr., S.M. in engineering from Harvard University . . .
graduate of the Laboratories' Communications Development Training Program.

Progress begins in the mind—in the perception and appreciation of new ideas. In the past the ideas that sparked progress too often had to wait on the random interest of genius. Today more and more new ideas come from men trained to an awareness of that which is yet to be accomplished.

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Flying into a starless night, the pilot's vision may reach a mere 50 yards. Yet he sees a storm brewing 150 miles ahead.

Within minutes he plots a slight change in course and flies a smooth, safe corridor *through* the weather. His passengers complete their trip in comfort and on schedule.

Credit RCA Electronics for the "Weather Eye" radar that makes all this possible. And United Air Lines' all-radar fleet for being first (among 24 leading airlines) to use this important development.

RCA has also produced radar to guide ships at sea, and track man-made satellites through space. RCA pioneered and developed color TV, produced the world's largest electronic computer, peanut-sized transistors and much, much more.

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**RADIO CORPORATION OF AMERICA**

# Guaranteeing effective missile performance at the count down...

## with a GREER GO NO-GO TEST SYSTEM

Missile readiness at the launching site is assured when put through its paces with a Greer Go No-Go Test System. Take for example the above missile test facility recently completed for a leading manufacturer of missiles.*

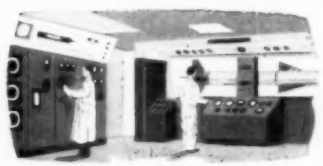
This unique Go No-Go System automatically and accurately tests missiles off the production line. The system encompasses every type of missile test including fuel, pneumatic, hydraulic, electrical, mechanical—all equipment designed, developed and built right in the Greer plant.

The fool-proof test system programs and schedules 32 different inputs for Go No-Go readout, and self-checks each input for accuracy before the actual test. Its special and multiple circuits provide rapid determination and isolation of defective parts in the missile. In addition, the equipment signals accurate operation of its own test circuits and components. All test conditions, altitude, speed, pressure, temperature, etc., are simulated and accurately controlled to match those in actual missile flight.

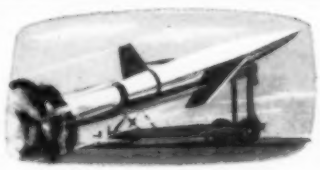
Bring your out-of-ordinary missile test problems to Greer. At your disposal is Greer's vast test equipment experience and know-how, Greer's staff of creative engineers and skilled technicians—plus a fully-equipped plant to do the job for on-time delivery. For immediate action contact Greer.

*For details, contact Greer sales manager, test equipment division.

## GREER GROUND SUPPORT EQUIPMENT



MISSILE GO NO-GO SYSTEMS



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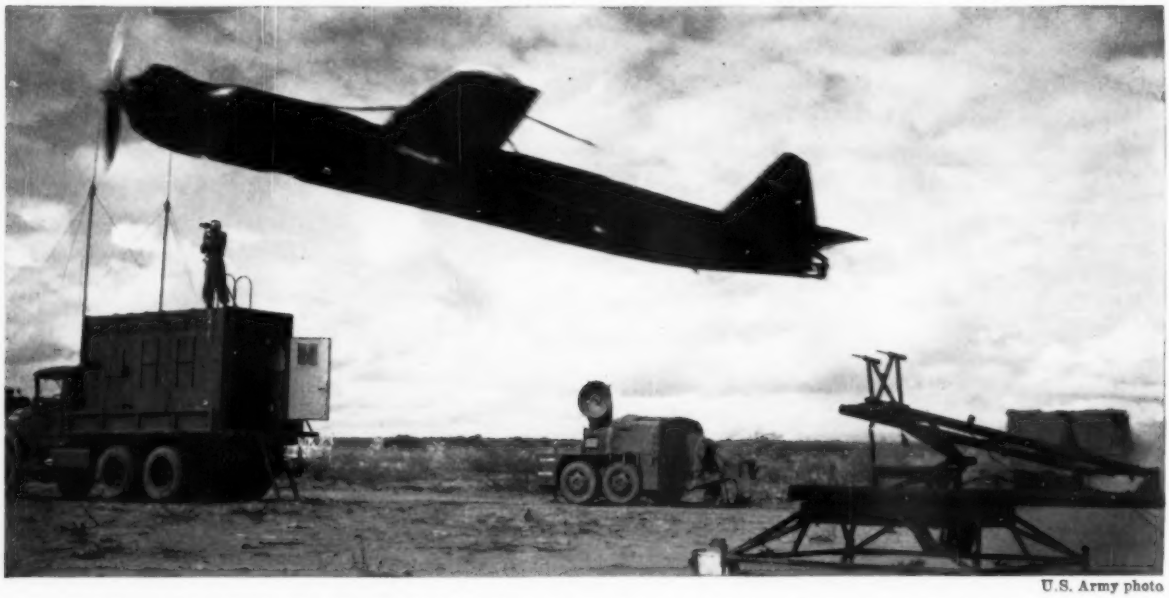

U.S. Army photo

Aerial drone being launched in test at Fort Huachuca. Remotely controlled by van equipment, it serves as a "flying camera" to spot enemy movements and installations.

# U. S. ARMY SIGNAL CORPS DEVELOPS ELECTRONICS FOR ATOMIC-AGE AT FORT HUACHUCA PROVING GROUND

Fort Huachuca, once a sleepy cavalry post, has come of age in the last few years. When the United States Army Electronic Proving Ground was established here in early 1954, this mile-high post was set upon a new trail marked by electron tubes, transistors, radar antennae, and television cameras.

Nestled against the base of the rugged Huachuca mountains about 100 miles south of Tuscon, its 70,000 plus acres are a beehive of electronic activity under United States Army Signal Corps direction. The many types of different terrain are ideal for the testing of electronic equipment.

Nearly 5,000 military personnel and approximately 2,000 civilian employees, many of them highly skilled scientists, are engaged in work at the Proving Ground.

The new look in defense is placing heavier burdens on the United States Army Signal Corps. This, of course, means more communications with new doctrines suited for employment in atomic war. The Combat Development Department at the Proving Ground has been experimenting along these lines. A new area system of battlefield communication designed to meet the threat of mass destruction from nuclear attack is now in the planning stages.

Meanwhile, the Signal Communications Department is conducting tests on both standard and experimental United States Army Signal Corps equipment to determine their future with the new look in defense. Under atomic attack, the use of extensive wires will not be practical. More radio communication is the answer, but ways to put more channels on radio frequency must be found.

With the spread-out of troops under atomic attack, increased surveillance of combat areas is a necessity. The Combat Surveillance Department of USAEPG is presently developing and testing a surveillance system with devices on the ground and in the air to bring reconnaissance and fire control information to the field commander.

Another important Proving Ground product is the "Flying Camera." A high speed camera is mounted in the fuselage of a remote-controlled drone aircraft. The aircraft is launched into the air by means of jet assist. When its mission is completed, the drone parachutes to the ground near the original launching site. Its up-to-the-minute pictures are developed, and the troops proceed to hit the pin-pointed areas of resistance.

* * *

These are just a few of the many projects under way at Fort Huachuca, helping to keep our country's military offense and defense the world's best.

This is one of a series of ads on the technical activities of the Department of Defense.

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DIVISION OF SPERRY RAND CORPORATION

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Engineers at Ford Instrument check out drone control system for United States Army project.

# FIREPOWER

**This section of ORDNANCE contains selected papers on armament technology presented at meetings of Technical Divisions and Committees of the American Ordnance Association and contemporary articles on armament research, development, manufacture, and field use**

# Mines—A Major Weapon

*These explosive devices can be employed for a wide variety of uses*

Lieut. Col. H. D. Ford

*Research and Development Division, U. S. Army Corps of Engineers*

IN World War II, land mines became a major weapon. American troops encountered many new types in the hands of the Germans, and the German Army is credited with bringing mine warfare to its present status. The Soviet Army also used mines to great advantage in the defense of their country. Realizing the value of mines, the Soviets have continued to maintain an advanced doctrine in mine warfare.

Today, mines are standard weapons with which all troops of all branches must be familiar. While Engineer and Infantry specialists will be required for complex mining and booby trapping, other combat troops, as well as administrative and technical-service troops, must be trained in the functioning, arming, and disarming of common mines and firing devices and must know how mines are laid and marked and how minefields may be breached.

MINING—in the sense of digging beneath enemy positions to cause their collapse—dates back several centuries before Christ. After explosives were invented they were placed in tunnels to destroy undermined positions.

One noteworthy example occurred in the late stages of the Civil War when the Union forces dug tunnels under Confederate entrenchments outside Petersburg, Va., and detonated explosives which caused large craters. Such tunnel-mines continued in use through World War I.

However, the development of tanks during this war brought about a revolutionary change in the concept of mining, for it was realized that mines must be placed to stop moving vehicles and troops rather than to blow up fixed targets. The first antitank mines were improvised from artillery shells.

The importance of mines for use against vehicles was not definitely established until World War II, when land mines as they are presently known—encased explosives fitted with fuzes or firing devices for actuation by the user or by the target itself—were extensively employed in the European theater to delay, channelize, or restrict an enemy advance.

WHEN the Germans invaded the Soviet Union, the Soviets turned to mines as one means of hindering the Germans. Soon they became experts, and learned to saturate areas with booby traps and improvised mines laid without regular pattern. They developed delayed-action chemical and clockwork fuzes; vibration, electrical, and magnetic-influence fuzes; and radio-controlled mines.

When the Soviets took the offensive, they did not relegate mines to a minor

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**A tank-mounted mine-exploding roller clears pressure mines before the tank reaches the danger point. Roller also absorbs explosion shock (Army photo).**

rôle but used them as an active combat weapon. Special mobile engineer units were formed to mine and demine areas during an attack. The U. S. Army Engineer School text on land mines states: "By the end of World War II, the Red Army was well ahead of other armies in the establishment of sound, battle-tested mine-warfare doctrine. They had designed and used in combat mines and fuzes which other nations are only now beginning to develop."

OTHER armies, including ours, were quick to utilize this weapon. The U. S. Army now classified minefields into the following five types:

1. Protective minefields which are used by small units for local close-in protection and to provide warning of enemy approach;

2. Defensive minefields, installed to strengthen a defensive position, disorganize enemy attacks, and channelize enemy movements;

3. Barrier minefields, large minefields laid to block enemy attack formations in selected regions and to deflect his approach into battle areas;

4. Nuisance minefields, used to delay or disorganize enemy troops and hinder enemy use of an area;

5. Phony minefields, used to deceive the enemy when lack of time or material prevents installation of a real minefield, to camouflage gaps in minefields, or conceal the true size of an active minefield.

A mine may be detonated by some action of its victim, by the passage of time, or by controlled means such as pressing a button or sending a radio impulse. It may explode, or release chemicals or poisons or fire.

Most common, however, are two types: *Antitank mines,* usually requiring 200 or more pounds' pressure for detonation, used primarily against vehicles; and *antipersonnel mines,* containing much smaller charges, intended to explode or scatter shrapnel and cause casualties among foot troops. Antipersonnel mines are usually used with antitank mines to hinder removal of the latter. Pressure-activated antipersonnel mines usually require a force of five to fifty pounds.

HOWEVER, mines may be set off in a number of ways besides pressure. Some firing devices function when a trip wire is pulled; some, when pressure is released; some, by magnetic action whenever metal is brought into the vicinity; and some will function whenever the mine is disturbed in any way. Most antitank mines have one or more activator wells into which firing devices may be inserted for booby trapping. Booby trapping of mines prevents easy removal by enemy troops.

Once planted and primed, a mine knows no friends. Therefore minelaying operations must be coördinated into operational plans. Careful records must be kept of all minefields and of paths left open through them so that friendly troops will not be endangered nor unduly hindered by their own mines and so that the mines may be efficiently removed when the need for them has passed.

Until recently, mines have been planted by hand under controlled and regulated procedures. Such hand planting required digging and then covering and concealing individual holes for each mine. However, the U. S. Army Corps of Engineers has developed a mechanical mine layer which greatly reduces the time required to lay antitank-type minefields.

In future military operations, with broader and deeper unit sectors, greater requirements for speed and mobility, greater dispersion of forces, and improved methods of mine laying, it is certain that land mines will continue to play an important part in warfare. The ability to breach an enemy minefield will be a correspondingly important part of the capability of all troops.

MINES, like most other instruments of warfare, are constantly becoming more complex, and consequently locating and removing them becomes more difficult and dangerous. Metallic-mine detectors already in the supply system will locate metallic mines and nonmetallic mines containing small pieces of metal, and other detectors are designed to locate mines having no metal parts. Portable mine detectors signal the locations of buried mines by changes in the sound coming through a listening device carried by the operator and also by changes on a visual indicator.

There is also a jeep-mounted mine detector capable of locating mines buried in and along roadways. This detector covers a path directly in front of the jeep, and can be moved to sweep either side of the vehicle. When the detector passes over a mine, the vehicle is automatically stopped.

Mine detectors now available are more efficient than those developed during World War II, but improvement in detection methods remains an urgent requirement.

Troops must be familiar with other means of detecting mines and minefields. They must be trained to be alert constantly for visible indications of mines and booby traps. Experience with the mining habits of a particular enemy is obviously of great help.

Some typical locations for mines are road intersections, potholes, road patches and soft spots in roadway surfaces, road shoulders, demolished installations, obstacles, and other areas where military vehicles may travel.

LOCATING the mines is only the first step in obtaining safe passage across a mined area. The mines must be removed or destroyed. The safest method is to destroy them in place with explosives. This can be done by carefully placing a charge of some standard military demolition explosive on top of each mine and detonating it from a safe distance.

Explosive charges specifically designed for clearing paths through minefields may also be used. One such device is the heavy, metal-cased, linear explosive charge called the demolition snake, which is pushed into a minefield and detonated to create a path wide enough for the passage of vehicles.

Mines also may be detonated in place by mechanical devices. The tank-mounted, mine-exploding roller is a recently developed device which can rapidly clear a path without requiring men on foot to locate or mark the mines. This roller has alloy-steel disk wheels about four feet in diameter and heavy enough to explode mines under most soil conditions. It can be attached to standard tanks and pushed through the suspected area, blowing up all mines in its path without endangering or exposing operating personnel.

FOOT troops may remove mines—even booby-trapped mines—by carefully tying ropes to them and then pulling the mines from their holes from a safe distance. Grapnels or weights attached to ropes may be flung, by hand or projectile, out into a field and dragged back; this method is especially effective against trip-wired mines. Bangalore torpedoes or small projected line charges also may be used to clear paths for foot soldiers. The most dangerous method of mine removal is by hand, and it is used only when the mines must be taken up without exploding them.

**Mines are automatically armed and planted at a predetermined rate by the Army's new mechanical antitank mine layer (Army photo).**

Though booby traps—sometimes called dirty-trick devices—are not technically mines, their use is closely related to mining. A booby trap is an explosive device designed to detonate when an unsuspecting person disturbs an apparently harmless object or does a presumably safe act. Standard mines may form the explosive charge; so may other explosives.

Booby traps may be adjusted to explode when some object such as a chair is moved; when a book or other object is lifted; when a whistle is blown or a doorbell rung; when an ignition key is turned; when a fire is lit, a window opened, a canteen used, a picture hung, and so forth. Almost anything movable can be booby-trapped.

Booby traps are sited to take advantage of human behavior characteristics such as the habitlike answering of telephones and turning on of lights; curiosity—such as the impulse to investigate a dispatch case, book, or weapon; acquisitiveness—the desire to acquire souvenirs and loot; or the desire for comfort which impels men to sit in chairs, lie on beds, or make fires.

The dispersion, speed, mobility, and independence of action of combat units was much greater in World War II than in any previous war. There is every reason to believe these factors will continue to increase in importance in any future wars. Because of these factors, devices such as land mines will be essential for protection of friendly troops and for the delay and control of the enemy.

**Weighing only 225 pounds, the new plastic jeep-mounted mine detector automatically stops the vehicle when the searchhead passes over a mine (Army photo).**

# Machine Tool Progress

*The vital machine-tool industry has come far during the preceding fifteen years, and many new automatic devices have contributed to greater production speeds with closer tolerances and finer finishes*

George F. Nordenholt

ALL designs of military equipment are being changed continually to keep up with progress. To achieve superiority of performance, the new designs call for more and more surface finishing, closer tolerances, smoother finishes, and more and more precise fits. Modern warfare will require many types of ordnance never used in past wars, and vastly more of it.

More so than ever before the winners of the wars of the future will be those nations that can throw into the battles and campaigns the greatest abundance of weapons and military machinery of the most advanced designs. That is why it is essential for this Nation to have a machine-tool industry that can deliver to the manufacturers of war matériel, in the shortest possible time, the best obtainable machine tools needed to produce, with greatest possible speed, the required weapons and equipment. The quantity and military quality of the fighting equipment that the Nation has ready for use will to an ever greater extent determine victory or defeat in future conflicts.

IT is a far cry from the clumsy tanks that rumbled over the sands of Africa to the present vastly more powerful and speedier combat vehicles equipped with a great variety of automatic controls. The modern jet fighter has electronic equipment that requires more man-hours to build and install than was required to produce a complete Mustang. The biggest and most complicated artillery shells, equipped with proximity fuzes as used in World War II, were child's play to make as contrasted with the smallest and simplest guided missile of today, the instrumentation and controls of which all but stagger the imagination.

*Mr. Nordenholt is editor emeritus of Product Engineering, New York, N. Y.*

Guns, tanks, airplanes, warships or any war equipment all must be produced to specifications of precision and performance accuracy that require not only vastly more machining but also machining to closer tolerances and smoother surfaces. Thus the manufacture of modern ordnance requires machine tools capable of faster cutting, able to produce to finer dimensional tolerance and to a higher surface finish. If and when the next war comes, unless such machine tools are made available to American industry quickly, that war may well be lost before this Nation is ready to do battle. Will our American machine-tool builders be able to meet the demands that will be put upon them when it becomes necessary to arm for an all-out war?

There are a number of ways by which the machine-tool builders are aiming to speed the tooling-up of American industry for emergency manufacture. Mass production gives amazing results. Therefore, if the machine-tool industry can concentrate on fewer varieties of standard machine tools, a greater number of machine tools of each type will be required, the man-hours to build a machine tool will be less, and more will be built in less time.

Also, machine-tool delivery will be speeded by the elimination, as far as possible, of specially designed automatic machines and standard machines that must be equipped with complicated fixtures and tooling and take much longer to build.

IN addition, the machine tools for modern ordnance manufacture must be able to produce repetitively to a higher degree of accuracy than ever before and at ever-increasing rates of production.

What indications are there that the machine-tool industry has the vitality, initiative, and aggressiveness to furnish quickly the tools required for the manufacture of ordnance on a war scale, when and if such an occasion arises? The answer to this question is clearly indicated by the progress in machine-tool design and production in the past and the activities of the present.

The last machine-tool exposition was held in Chicago in 1955. The machines on display unquestionably showed a far greater advance in design, adaptability, ease and flexibility of operation, automatic controls, and all other features than had been shown for at least the two preceding decades. This great ex-

hibit clearly demonstrated the vital initiative and aggressiveness of the machine-tool industry.

With reference to the over-all picture, A. V. Bodine, president of the Bodine Corporation and president of the National Machine Tool Builders Association, states:

"THE machine-tool industry is spending more time and money in research than ever before. Furthermore, it is availing itself of the research of other people whose productions are closely allied to the machine-tool and cutting-tool industry. Improvements are constantly being floor-tested and incorporated into the productions that are going into the plants of America. Coupled with this, I am happy to observe more men in the machine-tool industry attending numerous association meetings which indicates that the industry is definitely on the upgrade.

"The machine-tool industry can be counted upon to meet any national emergency that may be thrust upon it. We are doing our best to convince government that in the next emergency it should protect the industry in just two ways—first, leave our manpower alone for at least one year and, secondly, give us priority on raw materials to fabricate into finished products."

Mr. Bodine then goes on to say: "It would be extremely difficult for anyone to estimate how much quicker American industry will be able to tool up the next time in comparison with the last time. Special machine tools require many months to build even under the best conditions. Standard machine tools can be produced somewhat more rapidly. In either case, the efficiency of the machine-tool business in America today has been stepped up considerably by the acquisition of the most modern machine tools to build the machines that the industry produces.

"This fact alone should reduce the lead time necessary for the effective tooling up of American industrial production of twenty per cent as a conservative estimate. This, of course, is on the assumption that the Government agencies involved will quickly and completely reveal their requirements to the machine-tool industry, cutting out unnecessary red tape."

In line with the development of the above-mentioned philosophies in the machine-tool industry, one of the greatest strides has been in the direction of increasing the versatility of standard and general-purpose machine tools, thereby reducing the variety of machines required, as well as the number of special machine tools needed, and minimizing the need for highly complicated fixtures and special tools. All of these factors contribute significantly to reducing the lead time for the production of the machine tools needed for national defense.

The development that is responsible for much of the progress in minimizing special machine-tool requirements is the air-gage tracer control system. This has a double effect. It simplifies the machine-tool production problem and at the same time adds a great deal of flexibility in the use of the standard machines in the ordnance manufacturer's plant. Merely by the application to the lathe of either a flat or a round template the manufacturer can produce the desired contour to a repetitive machining accuracy of 0.0001-inch, even on the most complicated parts.

This high degree of accuracy permits the elimination of otherwise complicated gaging and complex procedures which are ordinarily considered mandatory. Without automatic repetitive accuracy of production it is not unusual, for example, for a single missile component to require as many as two hundred separate operations when the part is being machined by conventional manual control methods.

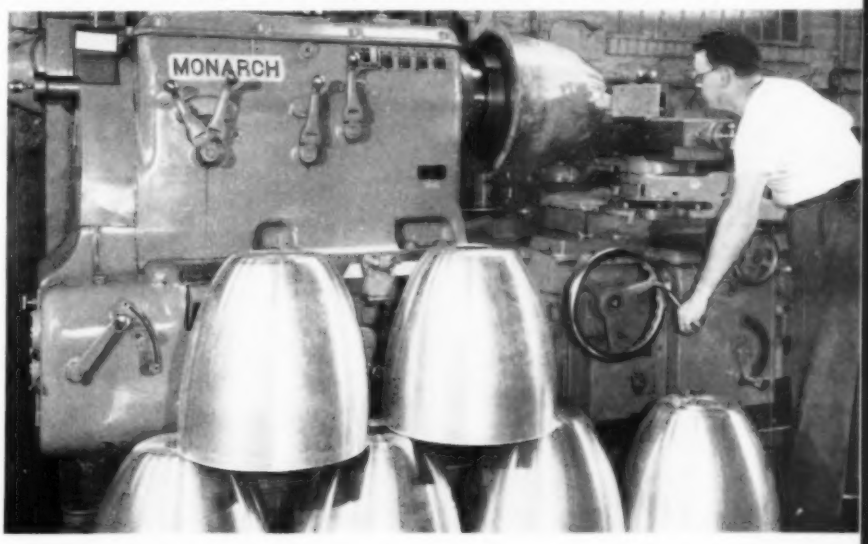
The accuracy of the air tracer has greatly reduced rejects and scrap caused by machining errors. And because missile components today are expensive forgings, the value of the high degree of machine accuracy and scrap reduction is obvious.

Probably of greater importance is the reduction of lead time in the plant of the ordnance manufacturer. It requires very little time to make a template out of sheet stock or by turning one on a lathe. The minimizing or elimination of gaging and inspection operations is another contribution to faster production per machine.

THERE also has been developed a tremendous increased productive capacity in machine tools both by virtue of the improvements in the machine tool itself and in the cutting tools used. Myron S. Curtis, vice-president in charge of engineering at Warner & Swasey Company, states:

"In our own production the higher rates have come through increased linear cutting speeds and easier, quicker operational handling of the machine tool rather than through increased feeds and increased depths of cut. Increased cutting speed is required in order to use the high-speed cutting capacities of tungsten carbides, titanium carbides, and the recently introduced

**Aluminum fairing skins for the F-102A are machined to satin-smooth finish with carbide tooling on an air-gage, tracer-equipped, heavy-duty lathe.**



ceramic cutting tools. As far as depth of cutting is concerned we have found that, because of the improved casting procedures, the depth of cut today is less than on all similar work fifteen years ago. Of course, to get the increased speeds the horsepowers of the driving motors of the machine tools have been greatly increased."

THROUGHOUT the machine-tool industry the cutting speeds have been vastly increased, as pointed out by Mr. Curtis. This has finally reached the point where the time consumed in manipulating the machine controls is often greater than the time consumed in cutting the material. To meet this situation, electrocycling has been developed and also the quick shifting of headstock gears in turret lathes.

Mr. Curtis also points out that "Perhaps one of our greatest contributions to production on short runs has come with the introduction of our single-spindle chucking machines and multiple-spindle automatic machines, both of which are primarily designed for short- and medium-run production. These machines bring the speed of automatic production to short runs, which are so prevalent in ordnance work and which were formerly performed on hand-operated machines."

One of the bottlenecks in the production of much of the ordnance equipment is in the short-run production. To produce a few hundred pieces or even a few thousand pieces on standard machine tools requires the availability of skilled operators. Such men are steadily becoming scarcer. There also always will be the human factor to cause variability in dimensions when the part is produced on a manually controlled standard machine. And, of course, many more machines will be required to produce a given quantity on a standard machine because of the much slower rate of manually controlled production.

One of the efforts of the machine-tool industry has been to transfer the skill requirements from the machine operator to the machine itself. In this, the industry has been gratifyingly successful.

This brings up the question of gaging. In previous wars, under the old conventional methods of machining parts it was common to find that quite a few pieces had been made before the machining error was discovered. This meant a great deal of lost time and lost parts. In ordnance production it is of paramount importance that repetitive accuracy shall be assured and that the parts shall be produced in a minimum time. If the gaging of the machine dimension is done during or immediately after the production of that dimension, the further making of defective parts is automatically prevented.

To meet such gaging requirements there have been developed manual, semiautomatic, and fully automatic gaging systems. These systems not only check dimensional accuracies but also check eccentricities, misalignments, quality of surface finish, and any other element that might be desired.

HAND in hand with the automatic gaging systems there have been developed machines that match the assembly of components to allowances that are very small fractions of the machining tolerances. Thereby the tolerances to which the matched parts are machined can be increased without increasing the fit allowances. The parts are matched-assembled with practically no manual labor involved. More generous machine tolerances mean faster machining with less down-time for tool sharpening and setting.

The importance of the application of autometrology for ordnance production is a highly significant contribution, as stated by Col. William J. Darmody, technical consultant to the Sheffield Corporation:

"Improper attention to duty and poor attitudes on the job can seriously hinder the attainment of desired quality objectives in the manufacture of ordnance items. The next mobilization may add to these adverse factors because of human minds being worried by the imminence of attack on our production facilities. Automatic inspection devices won't be subject to worry about being in the next target area. Their inclusion in mobile production facilities and arsenal pilot lines should be important aspects of armament preparedness."

The Sheffield Corporation has been a leader in the development of such automatic gaging and related equipment.

AMONG important developments in air-gaging is checking center distances, squareness of face to bore, and concentricity of alignment without effects from variation of hole sizes. Air circuits are being combined with electrical circuits to keep a close check on

**Contour tracing cross slide on saddle turret lathe completes complex shaft.**

numerous machining operations. If the part, which is checked as it is turned, is being produced within the specified tolerance, no signal is sent to the master control panel, and the machine continues its cycle of operation.

But if any dimension being gaged, almost simultaneously with its production, is out of tolerance, a signal is sent from the air-electrical gage circuit to a relay which stops the machine immediately. The operator then resets the tools. Foolproof devices are incorporated into this gage system so that the machine will be stopped automatically in the event of a broken tool or other trouble.

Another instrument will control the size of the dimension as it is being produced and then position the cutting tool as it wears so that the dimension produced will always be within the tolerances. This ensures that the machine will make no scrap parts and that production will be practically uninterrupted. This is the ideal method and is called "in-process gaging." It can be used with a grinder or a lathe and can control the various speeds of a grinding machine.

FOR example, in the grinding of the outside diameter of a shaft there may be applied a gage which will stop the fast feed of the grinding wheel when the outside shaft diameter gets down to 0.003-inch to 0.004-inch oversize. The gage control will automatically cause the machine to change to slow feed, and the slow feed of the wheel will continue until the outside diameter of the part is about 0.001-inch oversize.

The slow-feed gage control then stops the feed, allowing the wheel to spark out. In the final step, the spark-out control will back off the grinding wheel when the outside diameter being ground reaches exact size.

Often it is practically impossible to gage the part in process. Instead, the finished parts are put in conveyors and placed in feed channels that deliver the part to the gaging machine. Several machines may send the same part to the gaging machine which will select a part coming from each machine, gage it, signal back to the appropriate machine the correction required, and then segregate the finished parts into good, salvageable, and scrap parts.

One might well question the reliability of such gaging machines, but there is no need to worry. Where conditions warrant it, an automatic method is used to check the gage after a predetermined number of gaging cycles. A setting master is automatically placed into the gage which resets itself to zero. The master is then removed, and the normal gaging cycle is reëstablished.

*"The manufacture of modern ordnance requires machine tools capable of faster cutting, able to produce to finer dimensional tolerance and to a higher surface finish. Unless such machine tools are made available to American industry quickly, the next war may well be lost before this Nation is ready to do battle."*

These are only a few of the almost innumerable systems of gaging. Every system has the same objective; namely to contribute to the faster and more economical production of parts. Today the trend is toward the gaging of extremely small parts. These are becoming common, being more and more numerously used in guided missiles and various ordnance instruments.

The latest and perhaps the most significant development in machine-tool controls is that generally referred to as punched-tape controls. This new direction of machine-tool control has found its greatest application in milling machines, although it is equally applicable to almost any machine tool.

In the operation of a tape-control system as applied to machine tools, taking the Bendix system as an example, an engineer takes the finished drawing and transfers from it onto a printed form, called a process sheet, the various dimensions and data that relate to the surface to be machined.

THE process sheets are then given to a typist who copies off the numbers on a specially designed typewriter that simultaneously makes a copy of the process sheet and punches a tape. The tape is then fed to a computer which produces another tape which can be called the control tape. This last tape is put in the control cabinet of the milling machine or other tool.

As the tape feeds through the control cabinet the milling machine is automatically servocontrolled so that it will produce the desired part to the desired shape and to accuracies within a thousandth of an inch.

There are many variations of this control system, the above explanation of which has perhaps been oversimplified. The tape-control system at the moment finds its greatest application in the machining of airplane wing spars and other airplane structural elements that have irregular shape. The tape system also is being used for skin milling in the aircraft industry.

Only a few dozen such controls are now in use, and the whole field is still in its infancy although rapid progress is being made. Undoubtedly the system will be perfected to a point where it will be applied generally. It will prove to be a tremendous time saver especially in the building of prototype models, greatly reducing the lead time in the development of new designs of weapons and components.

It is not difficult to visualize the possibility of tape-controlled machines. It will enable the machining of small lots at a speed comparable to production in large lots. It will be necessary merely to apply and thread the control tape into the control cabinet of the machine and then start the machine after the piece has been mounted. A whole library of control tapes can be established for all the various pieces to be produced. If a part is to be changed in a few dimensions it is necessary merely to cut out of the tape that section that incorporates the changes and splice in a new section of tape that has been punched to produce the new dimensions. Lead time will be cut tremendously.

BEYOND any question, the machine-tool industry has come far during the past fifteen years—and it will continue to progress. Much more could be written about the different forms of cutting tools which perform fine-finish precision cutting operations and eliminate time-consuming grinding on jet engines and missile components. Innumerable developments have been achieved in the short time since World War II. The progress is continuing and will continue at an accelerated pace. There can be no question that the machine-tool industry will stand ready to do its full share if required in another emergency.

# Guiding the Terrier

*Complicated computers are necessary to solve problems of acquisition, tracking, prediction, ballistic lead angles, true and apparent wind*

R. M. Nolan

DESIGNING the control computer for Terrier guided missiles presented many unique problems. While basic control is similar to that of gunfire control, guiding a missile requires the solution of additional problems not found elsewhere. While security prevents the mention of the problems peculiar to the Terrier, some of the other uses of the control computer can be described.

The Terrier missile is installed on the cruisers U.S.S. BOSTON and U.S.S. CANBERRA. Upon launching, a booster rocket accelerates the missile from zero velocity to flight speed and then separates and drops away. When properly launched, the missile can be controlled to intercept its target, even though the target may be in motion throughout the missile's flight.

Besides solving the particular missile problems, the computer performs other functions not directly connected with missile control, such as gun-order computation and aërology wind-printer input computations. This versatile computer, the Mark 100, produced for the United States Navy Bureau of Ordnance by Ford Instrument Company, a division of Sperry Rand Corporation, operates in conjunction with search and tracking radar in Terrier guidance and control.

ESSENTIALLY, the functions of the Mark 100 computer in missile control are positioning the launcher and providing certain signals to the missile controlling search and tracking radar.

For computation of launcher orders, the fire-control problem to be solved is similar to an antiaircraft gunfire control problem in most respects. However, control of the Terrier requires the solution of additional problems peculiar to missiles. The basic problems common to both gunfire and missile control are target aquisition, tracking, prediction, ballistic lead angles, and geometric corrections.

*Mr. Nolan is an engineering writer with the Ford Instrument Company, Long Island City, N. Y.*

To solve the acquisition problem, designation signals that are initially orientated in the search and detection equipment coördinates are converted to the coördinate system of the tracking radar. The tracking radar transmits target-tracking data to the computer for solution of target position and rates.

For the solution of prediction, target movement is calculated from the computed rate and time of flight of the missile. The ballistic-lead-angle problem is solved by offsetting the line of fire of the missile. These offsets are lead angles that compensate for the departure of the missile from straight-line flight. Some of the factors considered in the solution are gravity, wind, and launcher motion.

Geometric correction is provided by correcting the line of fire for parallax base lengths between the computer and missile launcher.

Another problem requiring solution for missile guidance is the arrow weather-vane effect. This problem is incurred because of the Terrier's tendency to point into the wind at all times. At the low velocity present at launching time, the wind acting on the missile is, in effect, the apparent wind being felt at the launcher. This wind is a combination of true wind and apparent wind. The apparent wind is a force due to the combination of wind effect due to ship motion and wind effect due to rotational and translational motions of the missile launcher. The computer solves these factors and determines the proper offsets to the line of fire required to compensate for the combined effect of true and apparent wind.

The computer operates in three basic modes while accomplishing all its functions. These modes of operation are: acquisition mode, tracking mode, and nontactical mode.

IN the acquistion mode, designation information is received from target-designation equipment, ship's compass, and stable element. The computer then integrates these values and refers designation signals, corrected for pitch and roll, to the radar coördinate system. After target acquisition, the Mark 100 develops and transmits signals to target-designation equipment indicating the position of the tracked target in the coördinate axes of the weapon direction equipment displays.

The computer commences operation in the tracking mode upon reception from the tracking radar of the "on-target" signal. At this time, the Mark 100 disconnects all target-designation input data from the coördinate conversion circuits and reconnects these cir-

cuits for use in solving the coördinate conversion problems present in the tracking mode.

Smoothed relative target-motion rates are generated from the converted target data and combined with ballistic characteristics of the missile. The computer then determines orders to be delivered to the launcher, missile, and radar. In addition to the above, predicted target position and related tactical data on missile flight and performance are transmitted to display equipment.

IN the nontactical mode of operation the computer acquires the target balloon and automatically sets up the tracking mode. The computer then determines wind speed and bearing at given altitudes together with the north-south and east-west components of wind speed. These quantities are transmitted to an aërology wind printer.

The Mark 100 computer evolved from the Mark 84-85 computer system, a prototype installation aboard the U.S.S. Mississippi. While the Mark 84-85 computer performed somewhat similar functions to the Mark 100, this later computer is a much more complex and advanced missile controller. It is housed in two cabinets, one electronic and one mechanical, and automatically performs many functions which were performed manually by the Mark 84-85 computers.

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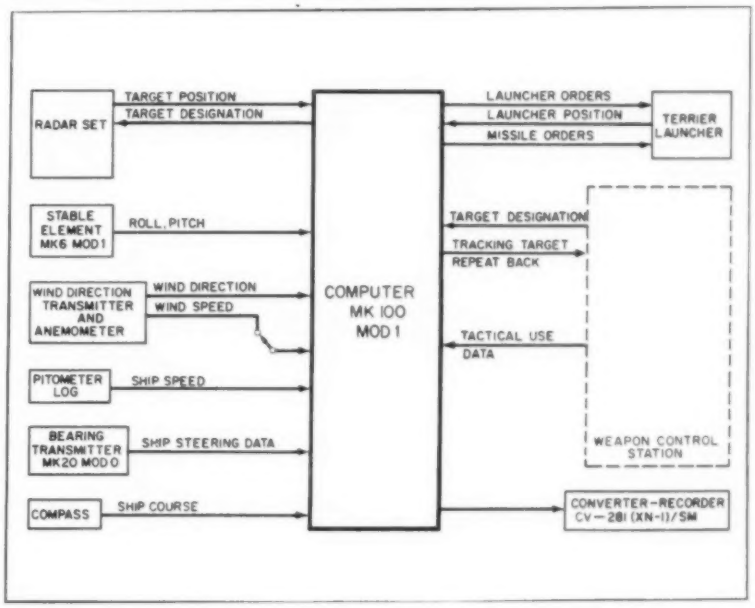
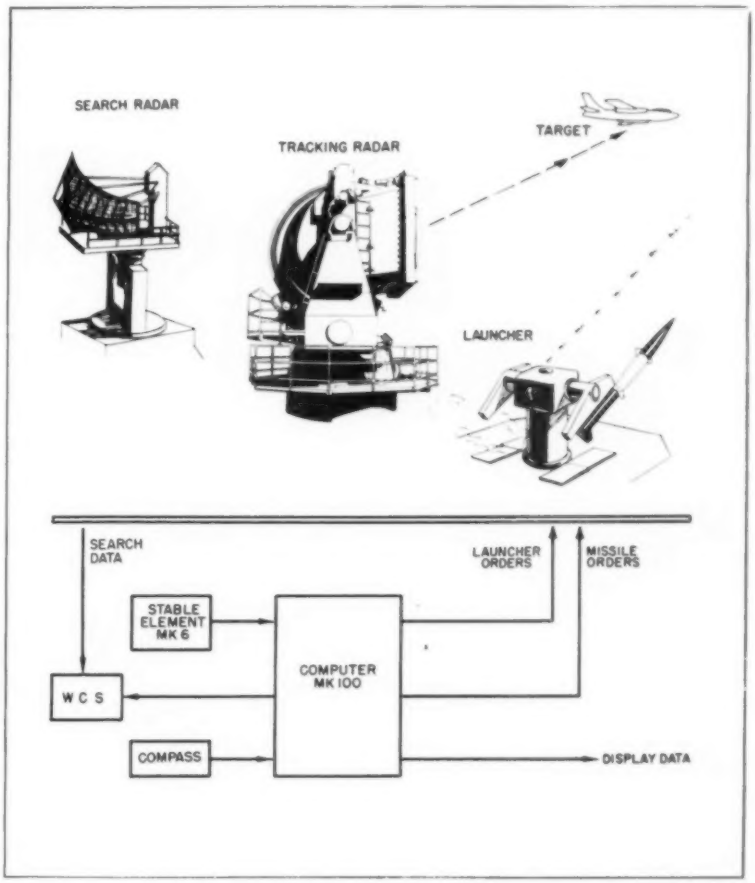
Editor's Note.—The following pertinent remarks of Vice Adm. John H. Sides, Director, Weapons Systems Evaluation Group, Department of Defense, appeared in Ordnance, Vol. XLII, No. 223:

"The advent of missiles into the arsenals of our armed services is leading to changes in military strategy, is dictating new tactical concepts, and is changing tactical dispositions of fleets and tactical compositions of land forces and air forces. We are in an era of evolution wherein missiles have replaced certain older systems and are supplementing and starting to replace certain other systems.

"This evolutionary period will span many years, but one day we shall come to the realization that the evolution will in fact have been a revolution and that guided missiles are the most important contributor to the strength of our armed forces."




**The diagram above indicates the major equipments of the Terrier fire-control system. The illustration below shows the Mark 100 computer in tracking mode receiving data from the search radar and issuing orders to missile and launcher.**



# High Strength Parts

## *Powder metallurgy can produce iron items in a single operation*

Jack Doelker

THE so-called high-density or high-strength ferrous parts made by the powder-metallurgy method and discussed here are composed entirely of iron. The high-density process was developed to produce parts which can be handled in the powdered-metal process, yet which are comparable in strength to those made of carbon steel. About the only type of powder that would do this job is electrolytic iron. It alone possessed the properties which enable it to be pressed and coined to relatively high densities.

By high densities, I mean something in excess of ninety per cent of the theoretical density. The high-density process actually involves the production of parts as high as ninety-seven per cent of the theoretical density. The electrolytic iron consists of particles that are very dense and very soft, due primarily to the fact that it is of such high purity, being at least 99.9 per cent pure. It has no additional alloy elements such as manganese or silicon in it to retard the full anneal.

In this process we are faced with the application of relatively high tonnages in the pressing and coining operations. We normally use about fifty tons per square inch. As a result, the tooling on it is much more critical than what you would normally experience in the other metal processes.

DUE to these factors we are almost exclusively limited to the use of carbide tools. These tools must have a very high degree of precision, particularly where thin sections are involved in the tooling, because when you come back not only from the pressing operation but from the coining operation where sintering causes a slight change in dimensions, the part must fit in the dies almost perfectly in order not to break out these thin sections.

*Mr. Doelker is with the Supermet Division of Globe Industries, Dayton, Ohio. This article was presented as a technical paper before a recent meeting of the A.O.A. Powder Metallurgy Committee held in Rye, N. Y.*

Carbide tooling, of course, is considerably more expensive than the standard type of steel tool. However, we have found that you can expect much longer die life on the parts. In the regular type of products you may produce possibly 500,000 parts before causing any serious loss in dimensional tolerance. We found that we have been able to press several million parts or more with carbide tools and still maintain those parts to very close dimensional tolerances.

The type of parts produced by the high-density process are somewhat limited in comparison with those that can be made by other powdered-metal processes. This is due to the fact that powder does not react like a hydraulic medium; therefore, when you involve different steps or levels on the parts, you must place the exact amount of powder in the proper position. In high density you have no chance for any variation—you are working up to the top limit of the material, and you must get every bit of it in place. In addition, the rate of compression must be very carefully controlled. In other words, each part or each section of a part must develop a density in the proper proportion and at the same rate.

While these factors naturally cause more difficulty in the processing, they are, however, the very ones which result in production of superior parts having very high physical characteristics, very high strengths, very good elongation characteristics, and very close dimensional control. These parts normally do not include anything but pure iron until after the final processing is completed; at that time carbon is usually added through a gas carburizing process. It has been found advisable to keep these parts as soft as possible during processing in order to compact them or coin them to the high densities required. Any addition of carbon, of course, would result in some hardening effect due to the sintering operation and also due to the effect of the combined carbon in the material and would cause an increase in hardness so that we would not be able to compact to the density levels we desire.

PARTS, however, when compacted to these high densities can be carburized very readily. They will develop very sharply defined and controllable cases, and that way we can actually incorporate the characteristics of the case-hardened part. They have a very hard wear-resistant surface combined with a tough core which increases the overall toughness of the part.

In the parts having lighter sections we can carburize all the way through with the proper type of equipment having carbon-potential control. In our carburizing furnaces we can carburize these parts to any given carbon level desired. In other words, if you want a 40, 60, 80, 90, or 100 points of carbon steel, each can be readily obtained.

This, of course, makes possible a

tremendous variety of characteristics, and the actual number is almost unlimited. They can be developed so they will very closely approximate those of standard steel parts.

The method of processing, of course, is very important. We can arrive at a given condition by several different methods involving the control of the initial pressing pressure and the initial and subsequent coining pressures. Each condition gives a different set of results —another factor which must be taken into consideration in processing these parts. Generally, however, it is advisable to compress the parts in the initial pressing operation at the highest possible pressure economically feasible, because from this condition we obtain the best physical characteristics. Also we are able to control more closely the conventional tolerances.

ON a single pressing and sintering operation we normally can obtain densities ranging from 6.8 to 7.3 grams per cubic centimeter. In that condition they will have a tensile strength of 28,000 to 38,000 pounds per square inch, a yield strength of 52,000 to 56,000, and elongations of 4 to 8 per cent.

The same parts given a second sintering operation after the coining will show a reduced tensile of 45 to 49 per cent due to the fact that we have alleviated the work-hardening which was induced during the coining operation. The yield strength will be 29,000 to 31,000 pounds per square inch, and the elongation will actually be in the neighborhood of 25 per cent or even greater.

From those three basic series, we can, of course, take the parts into various degrees of heat-treating or carburization. I will speak here primarily of the higher carbon range, being about 90 points of carbon. Now, taking the first series—pressing and sintering—those parts when carburized will exhibit tensile strengths of 75,000 to 95,000 pounds per square inch—a full-hardened condition. The parts having considerable porosity at that time (in the neighborhood of 10 to 12 per cent maximum) will be carburized all the way through. We can temper those particular parts back, of course, to various degrees of temperature and obtain quite a range of properties and also pick up some increase in elongation.

If we take the series that has had both the coining and the second sintering operation, we can come back in with a series of carburized treatments. Now, if we would throw in what we might call a light case, something less than 20 per cent of the cross-sectional area, those parts normally exhibit tensile strengths of 65,000 to 70,000 pounds per inch with 0.5 to 1.5 per cent elongation. Various tempering operations will again modify those characteristics, and if we would temper them back to about 1,000 degrees we would have a tensile strength of 53,000 to 58,000 tensile and about 7 per cent elongation.

If we want to put on a heavy case or to through-carburize the parts, then we obtain tensile strengths of 190,000 to 200,000 pounds per square inch. The yield strength, of course, will be very close to that same range due to the fact that it will be a full hard part and may have one per cent maximum elongation. Those parts again can be given various tempering operations.

Elongation is basically a gage of toughness. Elongation in these parts, of course, is not as good as in the straight carbon-steel parts or low-alloy-steel parts, due primarily to the fact that we are dealing here with 100 per cent iron. There is no manganese in the material, no silicon, no nickel, no chrome, and no alloy elements which tend to toughen the parts.

However, in many instances toughness is not required, but we can exhibit the tensile strength, the yield strength, and the hardnesses that are characteristic of many harder steels and the low-alloy grades. We can, of course, give considerably more variation by controlling the carbon potential of the carburizing atmosphere by making these parts into 40-point carbon steels instead of 90-point carbon steels or by making them into 60-point carbon steels. All these have, of course, characteristic ranges which very closely approximate those of the harder steels in the same carbon range.

SOME of the advantages of the high-density materials is that they first improve the strength of the sintered types of fabricated steels. They have relatively high impact strengths, though not as good as the regular fabricated type of steel. Finishes are superb as we are readily able to obtain and maintain surface finishes of eight microinches or less on the periphery of the parts. Normally the range is down around five microinches or less.

On the surfaces contacting the punches there is a condition that is governed by the finish on the punch. On those surfaces we normally have a surface finish of eight to eighteen microinches or less, depending upon the surface finish of the punch that is processing the part.

Dimensional control is very precise, and exceptionally close tolerances can be held. As I have already indicated, we have a high density range of 6.8 to about 7.65 grams per cubic centimeter, and that is solid iron. There are no other additions which would cause any increase in density. The theoretical solid of electrolytic iron is 7.87 grams per cubic centimeter, so we are very closely approaching the theoretical solid where required ductility exceeding 25 per cent can be obtained.

MACHINABILITY of this material is very good. It is practically the same as that for standard steel bar stock. I am not saying it is the same as for screw steels because there we have the addition of high sulphur and high manganese to give very free machining qualities. However, these parts will very closely approximate the machinability ratings of standard grades of 1010 steel. They are very easily heat-treated and, as I said before, they can be carburized to any carbon level desired—they can be cased or through-carburized. Parts can be plated just the same as any other ordinary type of steel part.

We need take no special precautions of sealing up pores—parts can be processed right in the same barrels or baths without any special treatments. This is due to the fact that the intercommunicating porosity of these parts is nonexistent. Even in the lower end of the high-density range, the intercommunicating porosity is nil and what little surface porosity is present in this lower end will not entrap any of the plating liquors.

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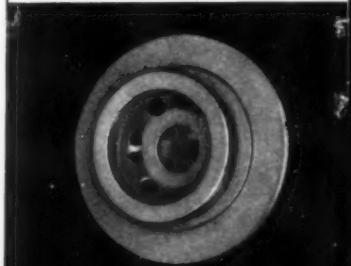

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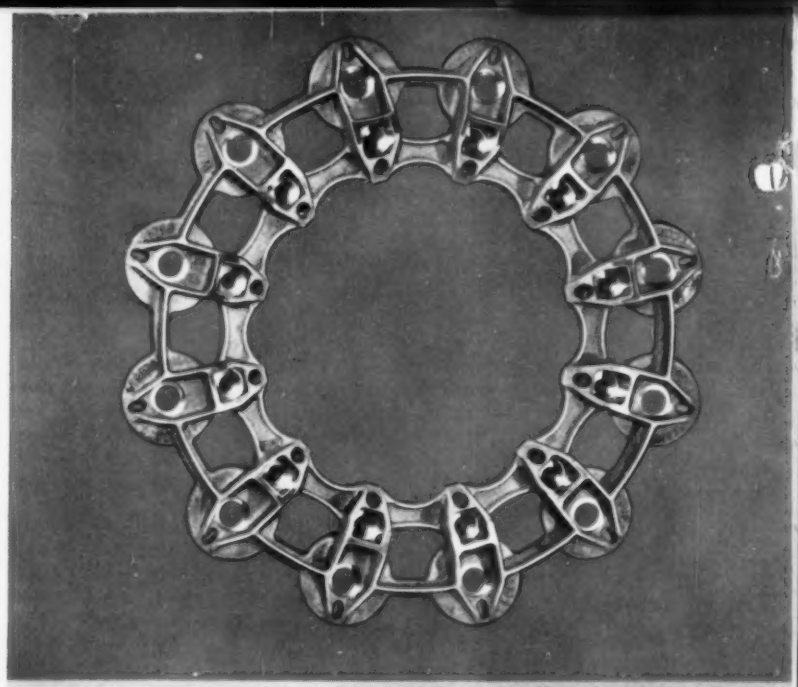

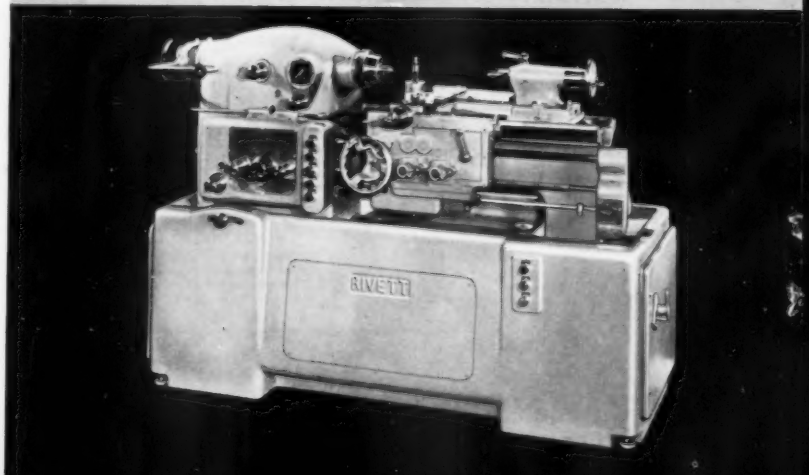

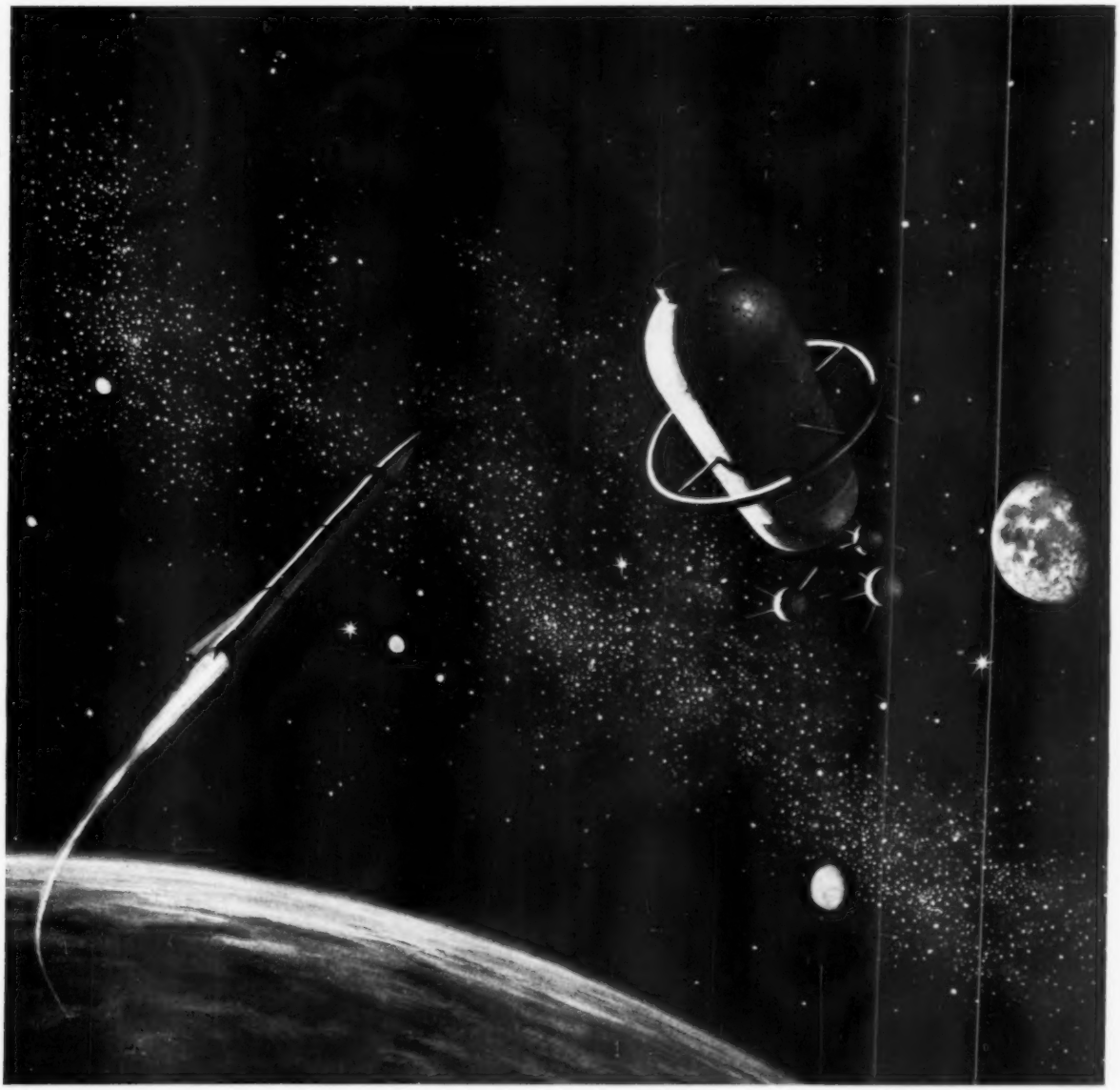

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